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Being Objective: Re-Examining Objects in SQL Server

If you're someone who's read my Professional level titles before, you'll find we're continuing the path we started in *Professional SQL Server 2005 Programming* and have the ''Professional'' become a little bit more ''Pro'' in level. That said, I still want to touch on all the basic objects and also address some things like new data types and additional objects that are new with SQL Server 2008.

So, What Exactly Do We Have Here?

Seems like sort of a silly question doesn't it? If you're here reading this title, you obviously know we have a database, but what makes up a database? It is my hope that, by now (meaning by the time you're ready for a professional level title), you've come to realize that a *Relational Database Management System* (*RDBMS*) is actually much more than data. Today's advanced RDBMSs not only store your data, they also manage that data for you, restricting what kind of data can go into the system, and also facilitating getting data out of the system. If all you want is to tuck the data away somewhere safe, you can use just about any data storage system. RDBMSs allow you to go beyond the storage of the data into the realm of defining what that data should look like — this has never been more true than with SQL Server 2008. Improved support for hierarchies means that you can store hierarchical data in a far more native way, and still access it very efficiently. The new Policy Based Management feature allows you to control many elements of how your data is administrated using a rules-driven approach. SQL Server also provides services that help automate how your data interacts with data from other systems through such powerful features as the SQL Server Agent, Integration Services, Notification Services, the increasingly popular Reporting Services, and more.

This chapter provides an overview to the core objects used in SQL Server. Much of what is discussed in this chapter may be old news for you at this stage of your database learning, so this is the only point in the book where we will call them out in broad terms of how they relate to each other. I will assume that you are already somewhat familiar with most of the objects discussed here, but the goal is to fill in any holes and fully prepare you for the more advanced discussions to come.

In this chapter, we will take a high-level look into:

- Database objects
- Data types (including some that are new with SQL Server 2008!)
- Other database concepts that ensure data integrity

An Overview of Database Objects

An RDBMS such as SQL Server contains many *objects*. Object purists out there may quibble with whether Microsoft's choice of what to call an object (and what not to) actually meets the normal definition of an object, but, for SQL Server's purposes, the list of some of the more important database objects can be said to contain such things as:

The database itself
The transaction log
Tables
Filegroups
Diagrams
Views
Stored procedures
User-defined functions
Indexes
CLR assemblies
Reports
Full-text catalogs
User-defined data types
Roles
Users
Encryption Keys

This is far from being a comprehensive list, and is in no particular order, but it does give you some of a feel for the breadth of objects that your SQL Server can manage.

The Database Object

The database is effectively the highest-level object that you can refer to within a given SQL Server. (Technically speaking, the server itself can be considered to be an object, but not from any real ''programming'' perspective, so we're not going there.) Most, but not all, other objects in a SQL Server are children of the database object.

If you are familiar with old versions of SQL Server you may now be saying, ''What? What happened to logins? What happened to Remote Servers and SQL Agent tasks?'' SQL Server has several other objects (as listed previously) that exist in support of the database. With the exception of linked servers, and perhaps Integration Services packages, these are primarily the domain of the database administrator and as such, you generally don't give them significant thought during the design and programming processes. (They are programmable via something called the SQL Management Objects [SMO], but that is far too special a case to concern you with here. We will look at SMO more fully in Chapter 26.)

A database is typically a group that includes at least a set of table objects and, more often than not, other objects, such as stored procedures and views that pertain to the data stored in the database's tables.

When you first load SQL Server, you will start with four system databases:

❑ master

❑ model

❑ msdb

❑ tempdb

All of these need to be installed for your server to run properly. (Indeed, for some of them, it won't run at all without them.) From there, things vary depending on which installation choices you made. Examples of some of the databases you may also see include the following:

❑ AdventureWorks or AdventureWorks2008 (the sample databases downloadable from `codeplex.com`)

❑ AdventureWorksLT or AdventureWorksLT2008 (a ''lite'' version of the main sample database)

❑ AdventureWorksDW or AdventureWorksDW2008 (sample for use with Analysis Services)

In addition to the primary examples supported by Microsoft, you may, when searching the Web or using other tutorials, find reference to a couple of older samples:

❑ pubs

❑ Northwind

The master Database

Every SQL Server, regardless of version or custom modifications, has the master database. This database holds a special set of tables (system tables) that keeps track of the system as a whole. For example, when you create a new database on the server, an entry is placed in the `sysdatabases` table in the master database (though, if you're interested in data from `sysdatabases`, you should only access it via the `sys.databases` metadata view). All extended and system stored procedures, regardless of which database they are intended for use with, are stored in this database. Obviously, since almost everything that describes your server is stored in here, this database is critical to your system and cannot be deleted.

The system tables, including those found in the master database, can, in a pinch, be extremely useful. That said, their direct use is diminishing in importance as Microsoft continues to give more and more other options for getting at system level information.

I used to be a significant user of system tables; that is no longer the case.

Microsoft has recommended against using the system tables since prior to version 7.0 (1998 or so?). They make absolutely no guarantees about compatibility in the master database between versions — indeed, they virtually guarantee that they will

change. The worst offense comes when performing updates on objects in the master database. Trust me when I tell you that altering these tables in any way is asking for a SQL Server that no longer functions. (I've saved a system doing this, and I've killed a system doing this; I don't like 50/50 odds with the life of my server . . . .).

Microsoft has created several alternatives (for example, system functions, system stored procedures, `information_schema` views, and a wide array of system metadata functions) for retrieving much of the information that is stored in the system tables. These alternatives are what you should be using.

The model Database

The model database is aptly named, in the sense that it's the model on which a copy can be based. The model database forms a template for any new database that you create. This means that you can, if you wish, alter the model database if you want to change what standard, newly created databases look like. For example, you could add a set of audit tables that you include in every database you build. You could also include a few user groups that would be cloned into every new database that was created on the system. Note that since this database serves as the template for any other database, it's a required database and must be left on the system; you cannot delete it.

There are several things to keep in mind when altering the model database. First, any database you create has to be at least as large as the model database. That means that if you alter the model database to be 100MB in size, you can't create a database smaller than 100MB. There are several other similar pitfalls. As such, for 90 percent of installations, I strongly recommend leaving this one alone.

The msdb Database

msdb is where the SQL Agent process stores any system tasks. If you schedule backups to run on a database nightly, there is an entry in msdb. Schedule a stored procedure for one-time execution, and yes, it has an entry in msdb. Other major subsystems in SQL Server make similar use of msdb. SQL Server Integration Services (SSIS) packages and Policy Based Management definitions are examples of other processes that make use of msdb.

The tempdb Database

tempdb is one of the key working areas for your server. Whenever you issue a complex or large query that SQL Server needs to build interim tables to solve, it does so in tempdb. Whenever you create a temporary table of your own, it is created in tempdb, even though you think you're creating it in the current database. Whenever there is a need for data to be stored temporarily, it's probably stored in tempdb.

tempdb is very different from any other database in that not only are the objects within it temporary, but the database itself is temporary. It has the distinction of being the only database in your system that is completely rebuilt from scratch every time you start your SQL Server.

Technically speaking, you can actually create objects yourself in tempdb — I strongly recommend against this practice. You can create temporary objects from within any database you have access to in your system — it will be stored in tempdb. Creating objects directly in tempdb gains you nothing but adds the confusion of referring to things across databases. This is another of those ''Don't go there!'' kind of things.

tempdb is dropped and rebuilt from scratch each time you restart your SQL Server.

AdventureWorks/AdventureWorks2008

SQL Server included samples long before these came along. The old samples had their shortcomings though. For example, they contained a few poor design practices. (I'll hold off the argument of whether the AdventureWorks databases have the same issue or not. Let's just say that AdventureWorks was, among other things, an attempt to address this problem.) In addition, they were simplistic and focused on demonstrating certain database concepts rather than on SQL Server as a product or even databases as a whole.

From the earliest stages of development of Yukon (the internal code name for what we look back on today as SQL Server 2005) Microsoft knew they wanted a far more robust sample database that would act as a sample for as much of the product as possible. AdventureWorks is the outcome of that effort. As much as you will hear me complain about its overly complex nature for the beginning user, it is a masterpiece in that it shows it *all* off. Okay, so it's not really *everything*, but it is a fairly complete sample, with more realistic volumes of data, complex structures, and sections that show samples for the vast majority of product features. In this sense, it's truly terrific. AdventureWorks2008 is the natural evolution of the original AdventureWorks database in the sense that it alters and extends the model to make use of features that are new with SQL Server 2008.

I use AdventureWorks2008 as the core sample database for this book.

AdventureWorksLT/AdventureWorksLT2008

The LT in this stands for lite. This is just an extremely small subset of the full AdventureWorks database. The idea is to provide a simpler sample set for easier training of basic concepts and simple training. While I've not been privy to the exact reasoning behind this new sample set, my suspicion was that it is an effort to try and kill the older Northwind and Pubs sample sets, which have been preferred by many trainers over the newer AdventureWorks set, as the AdventureWorks database is often far too complex and cumbersome for early training. However, I've recently heard that there are plans for some updating and additional development to the Northwind sample, so perhaps they aren't ready to totally kill that one off after all.

AdventureWorksDW/AdventureWorksDW2008

This is the Analysis Services sample. (The DW stands for data warehouse, which is the type of database over which most Analysis Services projects will be built.) Perhaps the greatest thing about it is that Microsoft had the foresight to tie the transaction database sample with the analysis sample, providing a whole set of samples that show the two of them working together.

We will utilize this database extensively when reviewing OLAP concepts and taking a look at Analysis Services. Take a look at the differences between the two databases. They are meant to serve the same fictional company, but they have different purposes; learn from this.

The Transaction Log

If you're far enough along in your SQL Server learning to be reading this title, then I would think you would have at least a basic familiarity with the log. That said, it is among the most misunderstood objects in SQL Server. Although the data is read from the database, any changes you make don't initially go to the database itself. Instead, they are written serially to the *transaction log*. At some later point in time, the database is issued a *checkpoint* — it is at that point in time that all the changes in the log are propagated to the actual database file.

The database is in a random access arrangement, but the log is serial in nature. While the random nature of the database file allows for speedy access, the serial nature of the log allows things to be tracked in the proper order. The log accumulates changes that are deemed as having been committed, and the server writes the changes to the physical database file(s) at a later time.

We'll take a much closer look at how things are logged in Chapter 11, but for now, remember that the log is the first place on disk that the data goes, and it's propagated to the actual database at a later time. You need both the database file and the transaction log to have a functional database.

The Most Basic Database Object: Table

Databases are made up of many things, but none are more central to the make-up of a database than tables. A table is made up of what is called *domain* data (columns) and *entity* data (rows). The actual data for a database is stored in tables. Each table definition contains the *metadata* (descriptive information about data) that describes the nature of the data the table is to contain. Each column has its own set of rules about what can be stored in that column. A violation of the rules of any one column can cause the system to reject an inserted row or an update to an existing row, or prevent the deletion of a row.

A table can have additional objects associated with it — these objects exist only within the construct of a particular table (or, in somewhat rare cases, a view). Let's take a look at each of these.

Indexes

An *index* is an object that exists only within the framework of a particular table or view. An index works much like the index does in the back of an encyclopedia; there is some sort of lookup (or ''key'') value that is sorted in a particular way, and, once you have that, you are provided another key with which you can look up the actual information you are after.

An index provides us ways of speeding the lookup of our information. Indexes fall into two categories:

- **Clustered —** You can have only one of these per table. If an index is clustered, it means that the table on which the clustered index is based is physically sorted according to that index. If you were indexing an encyclopedia, the clustered index would be the page numbers; the information in the encyclopedia is stored in the order of the page numbers.

- ❑ **Non-clustered —** You can have many of these for every table. This is more along the lines of what you probably think of when you hear the word *index*. This kind of index points to some other value that will let you find the data. For our encyclopedia, this would be the keyword index at the back of the book.

Note that views that have indexes — or *indexed views* — must have at least one clustered index before they can have any non-clustered indexes.

Triggers

A *trigger* is an object that generally exists only within the framework of a table. Triggers are pieces of logical code that are automatically executed when certain things, such as inserts, updates, or deletes, happen to your table. Triggers can be used for a great variety of things but are mainly used for either copying data as it is entered or checking the update to make sure that it meets some criteria.

A special kind of trigger — called a before trigger — can be associated with a view. We will take a more in-depth look at these in Chapter 12.

Constraints

A *constraint* is yet another object that exists only within the confines of a table. Constraints are much like they sound; they confine the data in your table to meet certain conditions. Constraints, in a way, compete with triggers as possible solutions to data integrity issues. They are not, however, the same thing; each has its own distinct advantages.

Unlike triggers and indexes, constraints can *only* be associated with tables (no views).

Schemas

Schemas provide an intermediate namespace between your database and the other objects it contains. The default schema in any database is dbo (which stands for database owner). Every user has a default schema, and SQL Server will search for objects within that user's default schema automatically. If, however, the object is within a namespace that is not the default for that user, then the object must be referred with two parts in the form of `<schema name>.<object name>`.

Schemas replace the concept of ''owner'' that was used in prior versions of SQL Server. While Microsoft now seems to be featuring their use (the idea is that you'll be able to refer to a group of tables by the schema they are in rather than listing them all), I remain dubious at best. In short, I believe they create far more problems than they solve, and I generally recommend against their use (I have made my exceptions, but they are very situational).

Filegroups

By default, all your tables and everything else about your database (except the log) are stored in a single file. That file is a member of what's called the *primary filegroup*. However, you are not stuck with this arrangement.

SQL Server allows you to define a little over 32,000 *secondary files*. (If you need more than that, perhaps it isn't SQL Server that has the problem.) These secondary files can be added to the primary filegroup or created as part of one or more *secondary filegroups*. While there is only one primary filegroup (and it is actually called ''Primary''), you can have up to 255 secondary filegroups. A secondary filegroup is created as an option to a `CREATE DATABASE` or `ALTER DATABASE` command.

The concept of a filegroup is there primarily to allow you to manage your physical storage of data in a somewhat segmented fashion. You can backup just the files in a given filegroup (rather than the entire database). You can use individual files to spread data across multiple physical storage devices (which may provide more I/O bandwidth).

Diagrams

A database diagram is a visual representation of the database design, including the various tables, the column names in each table, and the relationships between tables. In your travels as a developer, you may have heard of an *entity-relationship* diagram — or ERD. In an ERD the database is divided into two parts: entities (such as supplier and product) and relations (such as supplies and purchases).

> *The database design tools included in SQL Server 2008 remain a bit sparse. Indeed, the diagramming methodology the tools use doesn't adhere to any of the accepted standards in ER diagramming.*
>
> *Still, these diagramming tools really do provide all the ''necessary'' things; they are at least something of a start.*

Figure 1-1 is a diagram that shows some of the various tables in the AdventureWorks database. The diagram also (though it may be a bit subtle since this is new to you) describes many other properties about the database. Notice the tiny icons for keys and the infinity sign. These depict the nature of the relationship between two tables.

Views

A view is something of a virtual table. A view, for the most part, is used just like a table, except that it doesn't contain any data of its own. Instead, a view is merely a preplanned mapping and representation of the data stored in tables. The plan is stored in the database in the form of a query. This query calls for data from some, but not necessarily all, columns to be retrieved from one or more tables. The data retrieved may or may not (depending on the view definition) have to meet special criteria in order to be shown as data in that view. For most views, this serves two major purposes: security and ease of use. With views you can control what the users see, so if there is a section of a table that should be accessed by only a few users (for example, salary details), you can create a view that includes only those columns to which everyone is allowed access. In addition, the view can be tailored so that the user doesn't have to search through any unneeded information.

In addition to these most basic uses for view, we also have the ability to create what is called an *indexed view*. This is the same as any other view, except that we can now create an index against the view. This results in a few performance impacts (some positive, one negative):

- ❑ Views that reference multiple tables generally perform *much* faster with an indexed view because the join between the tables is preconstructed.

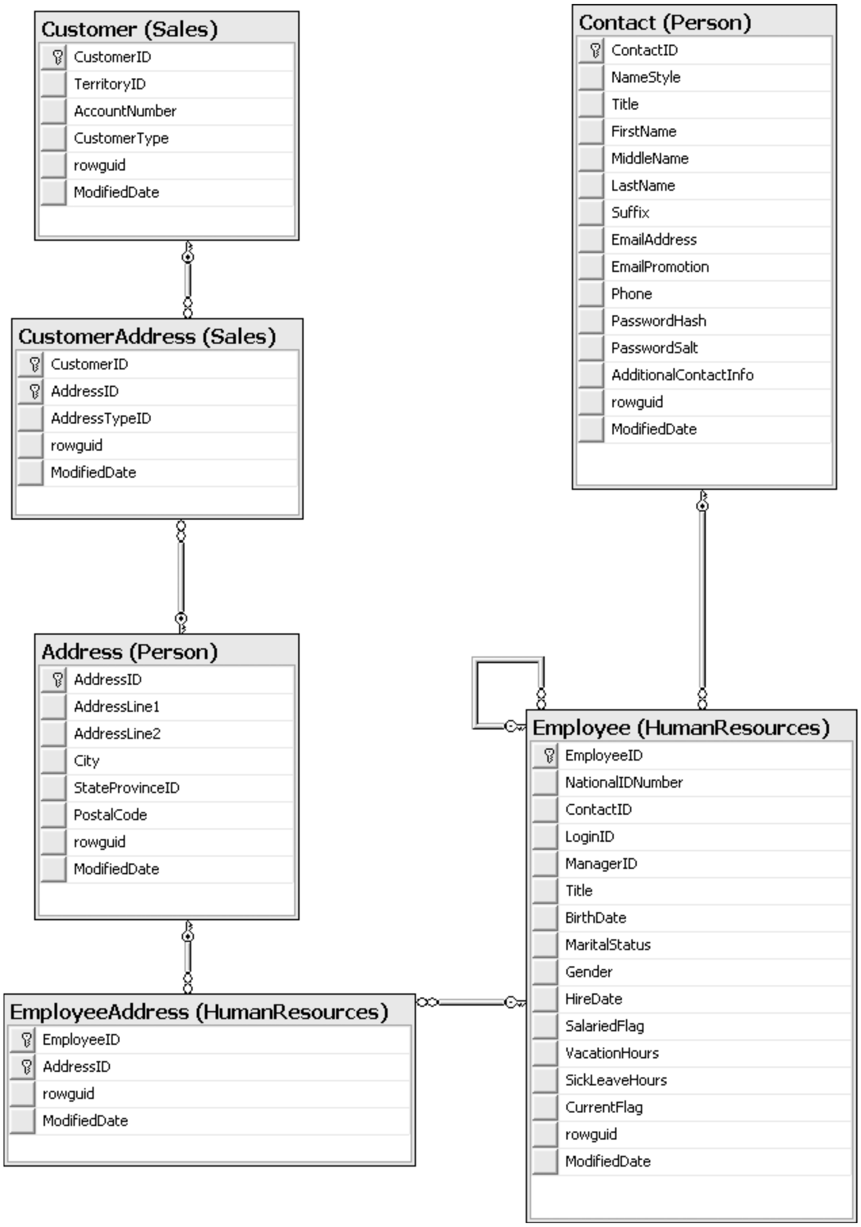


Figure 1-1

- Aggregations performed in the view are precalculated and stored as part of the index; again, this means that the aggregation is performed one time (when the row is inserted or updated), and then can be read directly from the index information.
- Inserts and deletes have higher overhead because the index on the view has to be updated immediately; updates also have higher overhead if the key column of the index is affected by the update.

We will look more deeply into these performance issues as well as other special uses for views in Chapter 8.

It is important to note that, while the code to create an indexed view will work in all editions, the query optimizer will only consider an indexed view when used in the Enterprise Edition of the product.

Stored Procedures

Stored procedures (or *sprocs*) are historically the bread and butter of programmatic functionality in SQL Server. Stored procedures are generally an ordered series of Transact-SQL (the language used to query Microsoft SQL Server) statements bundled up into a single logical unit. They allow for variables and parameters as well as selection and looping constructs. Sprocs offer several advantages over just sending individual statements to the server in the sense that they:

- Are referred to using short names, rather than a long string of text; as such, less network traffic is required in order to run the code within the sproc.
- Are pre-optimized and precompiled, saving a small amount of time each time the sproc is run.
- Encapsulate a process, usually for security reasons or just to hide the complexity of the database.
- Can be called from other sprocs, making them reusable in a somewhat limited sense.

In addition, you can utilize any .NET language to create assemblies and add program constructs beyond those native to T-SQL to your stored procedures.

User-Defined Functions

User-defined functions (or *UDFs*) have a tremendous number of similarities to sprocs, except that they:

- Can return a value of most SQL Server data types. Excluded return types include `text`, `ntext`, `image`, `cursor`, and `timestamp`. Note that you *can* return `varchar(max)` and `varbinary(max)` values.
- Can't have ''side effects.'' Basically, they can't do anything that reaches outside the scope of the function, such as changing tables, sending e-mails, or making system or database parameter changes.

UDFs are similar to the functions that you would use in a standard programming language such as VB.NET or C++. You can pass more than one variable in, and get a value out. SQL Server's UDFs vary from the functions found in many procedural languages, however, in that *all* variables passed into the function are passed in by value. If you're familiar with passing in variables `By Ref` in VB, or passing in pointers in C++, sorry, there is no equivalent here. There is, however, some good news in that you can return a special data type called a table. We'll examine the impact of this in Chapter 10.

Users and Roles

These two go hand in hand. *Users* are pretty much the equivalent of logins. In short, this object represents an identifier for someone to log in to the SQL Server. Anyone logging in to SQL Server has to map (directly or indirectly depending on the security model in use) to a user. Users, in turn, belong to one or more *roles*. Rights to perform certain actions in SQL Server can then be granted directly to a user or to a role to which one or more users belong.

Rules

Rules and constraints provide restriction information about what can go into a table. If an updated or inserted record violates a rule, then that insertion or update will be rejected. In addition, a rule can be used to define a restriction on a *user-defined data type*. Unlike rules, constraints aren't really objects unto themselves but rather pieces of metadata describing a particular table.

While Microsoft has not stated a particular version for doing so, they continue to warn that rules will be removed in a future release. Rules should be considered for backward compatibility only and should be avoided in new development. You should also begin phasing out any you already have in use in your database.

Defaults

There are two types of defaults. There is the default that is an object unto itself and the default that is not really an object, but rather metadata describing a particular column in a table (in much the same way that we have rules, which are objects, and constraints, which are not objects but metadata). They both serve the same purpose. If, when inserting a record, you don't provide the value of a column and that column has a default defined, a value will be inserted automatically as defined in the default.

Much like rules, the form of default that is its own object should be treated as a legacy object and avoided in new development and actively removed from existing code. Use of default constraints is, however, still very valid.

User-Defined Data Types

User-defined data types are extensions to the system-defined data types. The possibilities here are almost endless, but you must keep backward compatibility in mind. Although SQL Server 2000 and earlier had the idea of user-defined data types, they were really limited to different filtering of existing data types. Since SQL Server 2005, we have the ability to bind .NET assemblies to our own data types, meaning we can have a data type that stores (within reason) about anything we can store in a .NET object.

Careful with this! The data type that you're working with is pretty fundamental to your data and its storage. Although being able to define your own thing is very cool, recognize that it will almost certainly come with a large performance and most likely a security cost. Consider it carefully, be sure it's something you genuinely need, and then, as with everything like this, TEST, TEST, TEST!!!

Full-Text Catalogs

Full-text catalogs are mappings of data that speed the search for specific blocks of text within columns that have full-text searching enabled. Although these objects are joined at the hip to the tables and columns that they map, they are separate objects and are as such, not necessarily updated (the default is for automatic updating, but you can change it to manual update) when changes happen in the database.

SQL Server Data Types

This is an area of relatively significant change over the last release or two. SQL Server 2005 began the change in blob related data types (`text` and `ntext` became `varchar(max)` and `nvarchar(max)`, and image became `varbinary(max)`). Now SQL Server 2008 adds several new time and date related data types as well as a special data type for handling hierarchical data.

> *Note that since this book is intended for developers and that no developer could survive for 60 seconds without an understanding of data types, I'm going to assume that you already know how data types work and just need to know the particulars of SQL Server data types.*

SQL Server 2008 has the intrinsic data types shown in the following table:

Data Type Name	Class	Size in Bytes	Nature of the Data
`Bit`	Integer	1	The size is somewhat misleading. The first `bit` data type in a table takes up 1 byte; the next seven make use of the same byte. Allowing nulls causes an additional byte to be used.
`Bigint`	Integer	8	This just deals with the fact that we use larger and larger numbers on a more frequent basis. This one allows you to use whole numbers from -2^{63} to $2^{63}-1$. That's plus or minus about 92 quintrillion.
`Int`	Integer	4	Whole numbers from –2,147,483,648 to 2,147,483,647.
`SmallInt`	Integer	2	Whole numbers from –32,768 to 32,767.
`TinyInt`	Integer	1	Whole numbers from 0 to 255.
`Decimal` or `Numeric`	Decimal/ Numeric	Varies	Fixed precision and scale from $-10^{38}-1$ to $10^{38}-1$. The two names are synonymous.
`Money`	Money	8	Monetary units from -2^{63} to 2^{63} plus precision to four decimal places. Note that this could be any monetary unit, not just dollars.
`SmallMoney`	Money	4	Monetary units from –214,748.3648 to +214,748.3647.
`Float` (also a synonym for ANSI `Real`)	Approximate Numerics	Varies	Accepts an argument (for example, `Float(20)`) that determines size and precision. Note that the argument is in bits, not bytes. Ranges from $-1.79E + 308$ to $1.79E + 308$.

Data Type Name	Class	Size in Bytes	Nature of the Data
`DateTime`	Date/Time	8	Date and time data from January 1, 1753, to December 31, 9999, with an accuracy of three-hundredths of a second.
`DateTime2`	Date/Time	Varies (6-8)	Updated incarnation of the more venerable `DateTime` data type. Supports larger date ranges and large time fraction precision (up to 100 nanoseconds). Like `DateTime`, it is not time zone aware, but, does align with the .NET `DateTime` data type.
`SmallDateTime`	Date/Time	4	Date and time data from January 1, 1900, to June 6, 2079, with an accuracy of one minute.
`DateTimeOffset`	Date/Time	Varies (8-10)	Similar to the `DateTime` data type, but also expects an offset designation of −14:00 to +14:00 offset from UTC time. Time is stored internally as UTC time, and any comparisons, sorts, and indexing will be based on that unified time zone.
`Date`	Date/Time	3	Stores only `Date` data from January 1, 0001, to December 31, 9999 as defined by the Gregorian calendar. Assumes the ANSI standard date format (YYYY-MM-DD), but will implicitly convert from several other formats.
`Time`	Date/Time	Varies (3-5)	Stores only `Time` data in user-selectable precisions as granular as 100 nanoseconds (which is the default).
`Cursor`	Special Numeric	1	Pointer to a cursor. While the pointer takes up only a byte, keep in mind that the result set that makes up the actual cursor also takes up memory — exactly how much will vary depending on the result set.
`Timestamp/` `rowversion`	Special Numeric (binary)	8	Special value that is unique within a given database. Value is set by the database itself automatically every time the record is either inserted or updated — even though the timestamp column wasn't referred to by the `UPDATE` statement (you're actually not allowed to update the timestamp field directly).

Continued

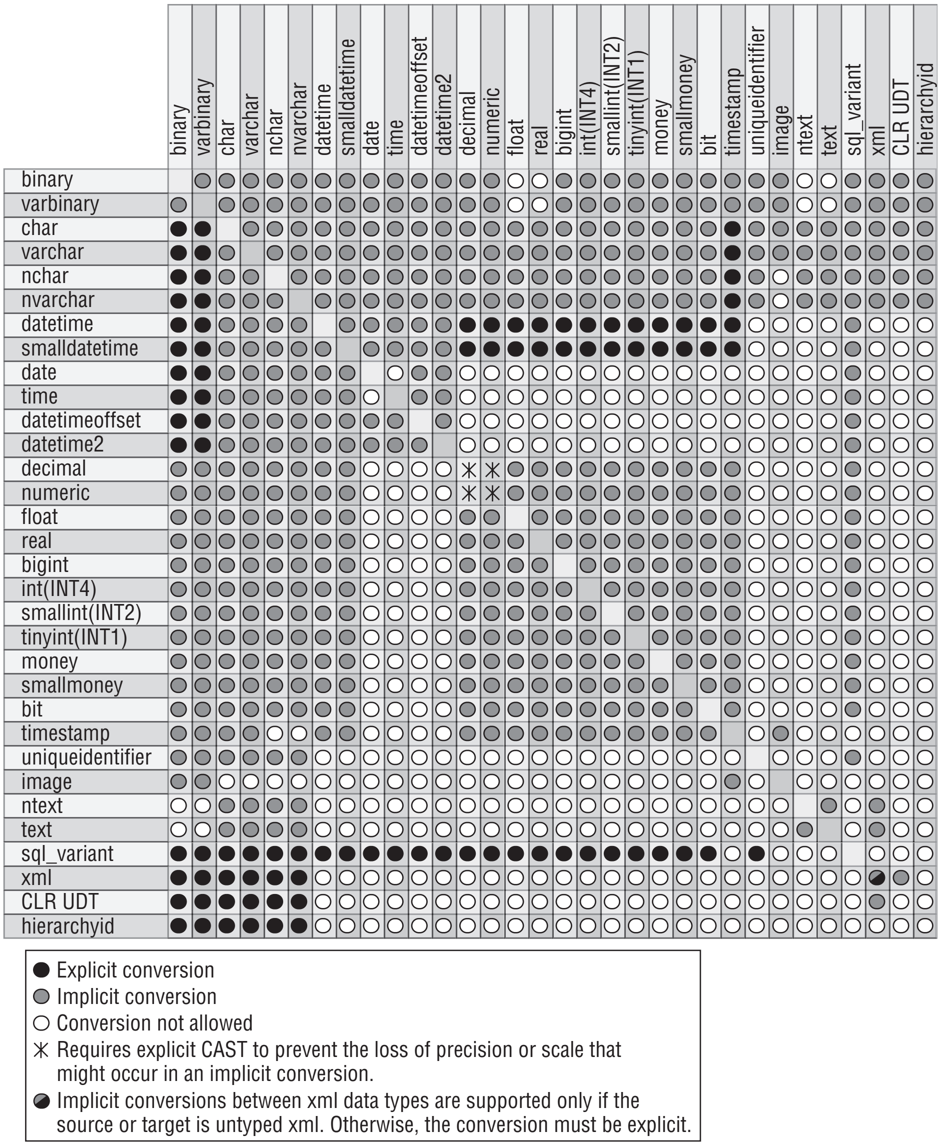
Data Type Name	Class	Size in Bytes	Nature of the Data
`UniqueIdentifier`	Special Numeric (binary)	16	Special Globally Unique Identifier (GUID). Is guaranteed to be unique across space and time.
`Char`	Character	Varies	Fixed-length character data. Values shorter than the set length are padded with spaces to the set length. Data is non-Unicode. Maximum specified length is 8,000 characters.
`VarChar`	Character	Varies	Variable-length character data. Values are not padded with spaces. Data is non-Unicode. Maximum specified length is 8,000 characters, but you can use the ‘‘max’’ keyword to indicate it as essentially a very large character field (up to 2 ˆ 31 bytes of data).
`Text`	Character	Varies	Legacy support as of SQL Server 2005 — use `varchar(max)` instead!
`NChar`	Unicode	Varies	Fixed-length Unicode character data. Values shorter than the set length are padded with spaces. Maximum specified length is 4,000 characters.
`NVarChar`	Unicode	Varies	Variable-length Unicode character data. Values are not padded. Maximum specified length is 4,000 characters, but you can use the ‘‘max’’ keyword to indicate it as essentially a very large character field (up to 2 ˆ 31 bytes of data).
`Ntext`	Unicode	Varies	Like the `Text` data type, this is legacy support only — in this case, use `nvarchar(max)`. Variable-length Unicode character data.
`Binary`	Binary	Varies	Fixed-length binary data with a maximum length of 8,000 bytes.
`VarBinary`	Binary	Varies	Variable-length binary data with a maximum specified length of 8,000 bytes, but you can use the ‘‘max’’ keyword to indicate it as essentially a LOB field (up to 2 ˆ 31 bytes of data).
`Image`	Binary	Varies	Legacy support only as of SQL Server 2005. Use `varbinary(max)` instead!

Data Type Name	Class	Size in Bytes	Nature of the Data
`Table`	Other	Special	This is primarily for use in working with result sets — typically passing one out of a User-defined Function or as a parameter for Stored Procedures. Not usable as a data type within a table definition (you can't nest tables).
`HierarchyID`	Other	Special	Special data type that maintains hierarchy positioning information. Provides special functionality specific to hierarchy needs. Comparisons of depth, parent/child relationships, and indexing are allowed. Exact size varies with the number of and average depth of nodes in the hierarchy.
`Sql_variant`	Other	Special	This is loosely related to the Variant in VB and C++. Essentially, it is a container that allows you to hold most other SQL Server data types in it. That means you can use this when one column or function needs to be able to deal with multiple data types. Unlike VB, using this data type forces you to *explicitly* cast it in order to convert it to a more specific data type.
`XML`	Character	Varies	Defines a character field as being for XML data. Provides for the validation of data against an XML Schema as well as the use of special XML-oriented functions.

Note that compatibility with .NET data types is even stronger than it was before. For example, the new `date` and `time` cross neatly into the .NET world, and the new `datetime2` data type also crosses to .NET more cleanly than the previous `datetime` data type does.

Unfortunately, SQL Server continues to have no concept of unsigned numeric data types. If you need to allow for larger numbers than the signed data type allows, consider using a larger signed data type. If you need to prevent the use of negative numbers, consider using a `CHECK` constraint that restricts valid data to greater than or equal to zero.

In general, SQL Server data types work much as you would expect given experience in most other modern programming languages. Adding numbers yields a sum, but adding strings concatenates them. When you mix the usage or assignment of variables or fields of different data types, a number of types convert implicitly (or automatically). Most other types can be converted explicitly. (You say specifically what type you want to convert to.) A few can't be converted between at all. Figure 1-2 contains a chart that shows the various possible conversions.



	binary	varbinary	char	varchar	nchar	nvarchar	datetime	smalldatetime	date	time	datetimeoffset	datetime2	decimal	numeric	float	real	bigint	int(INT4)	smallint(INT2)	tinyint(INT1)	money	smallmoney	bit	timestamp	uniqueidentifier	image	ntext	text	sql_variant	xml	CLR UDT	hierarchyid
binary		◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	○	○	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	○	○	◉	◉	◉	◉
varbinary	◉		◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	○	○	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	○	○	◉	◉	◉	◉
char	●	●		◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	●	◉	◉	◉	◉	◉	◉	◉	◉
varchar	●	●	◉		◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	●	◉	◉	◉	◉	◉	◉	◉	◉
nchar	●	●	◉	◉		◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	●	◉	○	◉	◉	◉	◉	◉	◉
nvarchar	●	●	◉	◉	◉		◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	●	◉	○	◉	◉	◉	◉	◉	◉
datetime	●	●	◉	◉	◉	◉		◉	◉	◉	◉	◉	●	●	●	●	●	●	●	●	●	●	●	●	○	○	○	○	◉	○	○	○
smalldatetime	●	●	◉	◉	◉	◉	◉		◉	◉	◉	◉	●	●	●	●	●	●	●	●	●	●	●	●	○	○	○	○	◉	○	○	○
date	●	●	◉	◉	◉	◉	◉	◉		○	◉	◉	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	◉	○	○	○
time	●	●	◉	◉	◉	◉	◉	◉	○		◉	◉	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	◉	○	○	○
datetimeoffset	●	●	◉	◉	◉	◉	◉	◉	◉	◉		◉	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	◉	○	○	○
datetime2	●	●	◉	◉	◉	◉	◉	◉	◉	◉	◉		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	◉	○	○	○
decimal	◉	◉	◉	◉	◉	◉	◉	◉	○	○	○	○	⚹	⚹	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	○	○	○	○	◉	○	○	○
numeric	◉	◉	◉	◉	◉	◉	◉	◉	○	○	○	○	⚹	⚹	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	○	○	○	○	◉	○	○	○
float	◉	◉	◉	◉	◉	◉	◉	◉	○	○	○	○	◉	◉		◉	◉	◉	◉	◉	◉	◉	◉	◉	○	○	○	○	◉	○	○	○
real	◉	◉	◉	◉	◉	◉	◉	◉	○	○	○	○	◉	◉	◉		◉	◉	◉	◉	◉	◉	◉	◉	○	○	○	○	◉	○	○	○
bigint	◉	◉	◉	◉	◉	◉	◉	◉	○	○	○	○	◉	◉	◉	◉		◉	◉	◉	◉	◉	◉	◉	○	○	○	○	◉	○	○	○
int(INT4)	◉	◉	◉	◉	◉	◉	◉	◉	○	○	○	○	◉	◉	◉	◉	◉		◉	◉	◉	◉	◉	◉	○	○	○	○	◉	○	○	○
smallint(INT2)	◉	◉	◉	◉	◉	◉	◉	◉	○	○	○	○	◉	◉	◉	◉	◉	◉		◉	◉	◉	◉	◉	○	○	○	○	◉	○	○	○
tinyint(INT1)	◉	◉	◉	◉	◉	◉	◉	◉	○	○	○	○	◉	◉	◉	◉	◉	◉	◉		◉	◉	◉	◉	○	○	○	○	◉	○	○	○
money	◉	◉	◉	◉	◉	◉	◉	◉	○	○	○	○	◉	◉	◉	◉	◉	◉	◉	◉		◉	◉	◉	○	○	○	○	◉	○	○	○
smallmoney	◉	◉	◉	◉	◉	◉	◉	◉	○	○	○	○	◉	◉	◉	◉	◉	◉	◉	◉	◉		◉	◉	○	○	○	○	◉	○	○	○
bit	◉	◉	◉	◉	◉	◉	◉	◉	○	○	○	○	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉		◉	○	○	○	○	◉	○	○	○
timestamp	◉	◉	◉	◉	○	○	◉	◉	○	○	○	○	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉		○	◉	○	○	○	○	○	○
uniqueidentifier	◉	◉	◉	◉	◉	◉	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		○	○	○	◉	○	○	○
image	◉	◉	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	◉	○		○	○	○	○	○	○
ntext	○	○	◉	◉	◉	◉	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		◉	○	◉	○	○
text	○	○	◉	◉	◉	◉	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	◉		○	◉	○	○
sql_variant	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	○	●	○	○	○		○	○	○
xml	●	●	●	●	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	◐	◉	○
CLR UDT	●	●	●	●	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	◉	○	○
hierarchyid	●	●	●	●	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

● Explicit conversion
◉ Implicit conversion
○ Conversion not allowed
⚹ Requires explicit CAST to prevent the loss of precision or scale that might occur in an implicit conversion.
◐ Implicit conversions between xml data types are supported only if the source or target is untyped xml. Otherwise, the conversion must be explicit.

Figure 1-2

In short, data types in SQL Server perform much the same function that they do in other programming environments. They help prevent programming bugs by ensuring that the data supplied is of the same nature that the data is supposed to be (remember 1/1/1980 means something different as a date than as a number) and ensures that the kind of operation performed is what you expect.

NULL Data

What if you have a row that doesn't have any data for a particular column — that is, what if you simply don't know the value? For example, let's say that we have a record that is trying to store the company performance information for a given year. Now, imagine that one of the fields is a percentage growth over the prior year, but you don't have records for the year before the first record in your database. You might be tempted to just enter a zero in the `PercentGrowth` column. Would that provide the right information though? People who didn't know better might think that meant you had zero percent growth, when the fact is that you simply don't know the value for that year.

Values that are indeterminate are said to be `NULL`. It seems that every time I teach a class in programming, at least one student asks me to define the value of `NULL`. Well, that's a tough one, because, by definition, a `NULL` value means that you don't know what the value is. It could be 1; it could be 347; it could be –294 for all we know. In short, it means *undefined* or perhaps *not applicable*.

SQL Server Identifiers for Objects

Now you've heard all sorts of things about objects in SQL Server. But let's take a closer look at naming objects in SQL Server.

What Gets Named?

Basically, everything has a name in SQL Server. Here's a partial list:

- Stored procedures
- Views
- Defaults
- Triggers
- User-defined functions
- Full-text catalogs
- Schemas
- Tables
- Rules
- Indexes
- Databases
- Logins
- Files
- Columns
- Constraints
- Filegroups
- Servers
- Roles
- User-defined types

And the list goes on. Most things I can think of except rows (which aren't really objects) have a name. The trick is to make every name both useful and practical.

Rules for Naming

The rules for naming in SQL Server are fairly relaxed, allowing things like embedded spaces and even keywords in names. Like most freedoms, however, it's easy to make some bad choices and get yourself into trouble.

Here are the main rules:

- The name of your object must start with any letter as defined by the specification for Unicode 3.2. This includes the letters most westerners are used to — A–Z and a–z. Whether ''A'' is different from ''a'' depends on the way your server is configured, but either makes for a valid beginning to an object name. After that first letter, you're pretty much free to run wild; almost any character will do.
- The name can be up to 128 characters for normal objects and 116 for temporary objects.
- Any names that are the same as SQL Server keywords or contain embedded spaces must be enclosed in double quotes (`""`) or square brackets (`[]`). Which words are considered keywords varies, depending on the compatibility level to which you have set your database.

Note that double quotes are acceptable as a delimiter for column names only if you have set `QUOTED_IDENTIFIER` *on. Using square brackets (*`[` *and* `]`*) eliminates the chance that your users will have the wrong setting but is not as platform independent as double quotes are. I do, however, recommend against having* `QUOTED IDENTIFIER` *on due to issues it can create with indexed views.*

These rules are generally referred to as the rules for identifiers and are in force for any objects you name in SQL Server. Additional rules may exist for specific object types.

I can't stress enough the importance of avoiding the use of SQL Server keywords or embedded spaces in names. Although both are technically legal as long as you qualify them, naming things this way will cause you no end of grief.

Summary

Database data has *type*, just as most other programming environments do. Most things that you do in SQL Server are going to have at least some consideration of type. While very little has changed in terms of basic objects available in SQL Server 2008, several new data types have been added. Be sure and review these new types (in the date and time arena as well as hierarchical data support). Review the types that are available, and think about how these types map to the data types in any programming environment with which you are familiar.

Consider the many objects available to you in SQL Server 2008. While you should be pretty familiar with tables and the basics of views and scripting prior to using this book (if not, you may want to take a look at *Beginning SQL Server 2008 Programming*), my hope is that you also realize that tossing together a few tables and a stored procedure or two seldom makes a real database. The things that make today's RDBMSs great are the extra things — the objects that enable you to place functionality and business rules that are associated with the data right into the database with the data.