

Microsoft SQL Server Installation Guide

For SQL Server 2019 Developer

January 2020



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Introduction

These instructions are used by students enrolled in the Master of Science in Computer Information Systems and other Computer Science Department programs in both on-campus and online programs. In some places these instructions say that you should contact your instructor. Online students should normally contact their facilitator first.

The document begins with discussion SQL Server editions and how they are utilized in our courses, downloading SQL Server from Microsoft and installing SQL Server itself. We continually update this document; please let us know of problems you encounter or questions not answered.

The examples in the main document are for the Microsoft Windows family, including Windows Server 2016 & Windows 10.

These setup instructions are for SQL Server 2019 Developer Edition, however can be used in installing other versions from 2012 and 2016 families.

SQL Server Overview

You or may not have various opinions about SQL Server and other database systems, but you can be confident that SQL Server has many of the advanced features available in relational database management systems, and that SQL Server is widely used worldwide. SQL Server supports many of the ANSI/ISO SQL standards, so when you learn SQL Server you are mainly close to the portable standards. SQL Server, developed by Microsoft, runs on Windows platforms, and on Linux as well. SQL Server is scalable, and supports both clustering and cloud computing through Azure to surpass the performance and reliability of any single platform. SQL Server is an in-demand, capable database system.

SQL Server Editions

SQL Server is released in several editions. To simplify your selection, we will focus on the Developer and the Express editions. For both CS 669, the express edition will work just fine, however for CS 779 we recommend that you use the Developer Edition. The Developer Edition has the same full feature set as the Enterprise Edition with the exception of the license. Production environments cannot be implemented using the Developer Edition. Please refer to the SQL Server Web site for comparison of editions. <https://www.microsoft.com/en-us/cloud-platform/sql-server-editions>

The Developer Edition is especially useful for those students who plan investigate advanced SQL Server topics as part of their CS 779 term project. Our installation instructions explain which features you may find useful for either course.

The Express Edition can be used for all the CS 669 and CS 779 assignments. The Express Edition is a free version of SQL Server which is a smaller version that places limits on the size of the database, computing capacity and feature set. For some of the MET courses, we have found that the Express Edition is suitable on the most part, and has advantages of a much smaller load on the computer and simpler installation.

For additional details on the features supported by both the Developer (Enterprise), Express as well as other editions please refer to the Features Supported by the Editions of SQL Server which can be found here: <https://download.microsoft.com/download/2/9/0/290f991b-5971-42e5-bb2c-81f700622b2e/SQL%20Server%202019%20Editions%20Datasheet.pdf>

SQL Server Express Edition

This guide covers installation of the Developer edition of SQL Server which is suitable for all classes. For installing the Express edition follow the instructions in the *SQL Server Express Installation Guide* instead of the instructions in this document.

Downloading SQL Server Installer

Microsoft SQL Server Download site

You will find the Developer edition download from the Microsoft SQL server download site.

<https://www.microsoft.com/en-us/sql-server/sql-server-downloads>



Developer

SQL Server 2019 Developer is a full-featured free edition, licensed for use as a development and test database in a non-production environment.

[Download now ↓](#)

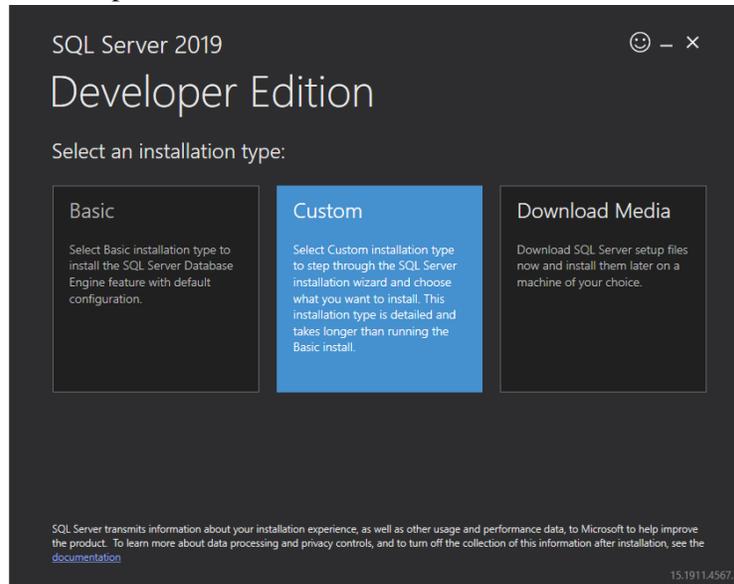
Once the download is complete, go to the destination folder (i.e. *downloads* folder on your computer). The installation file will look something like this:

 [SQL2019-SSEI-Dev](#)

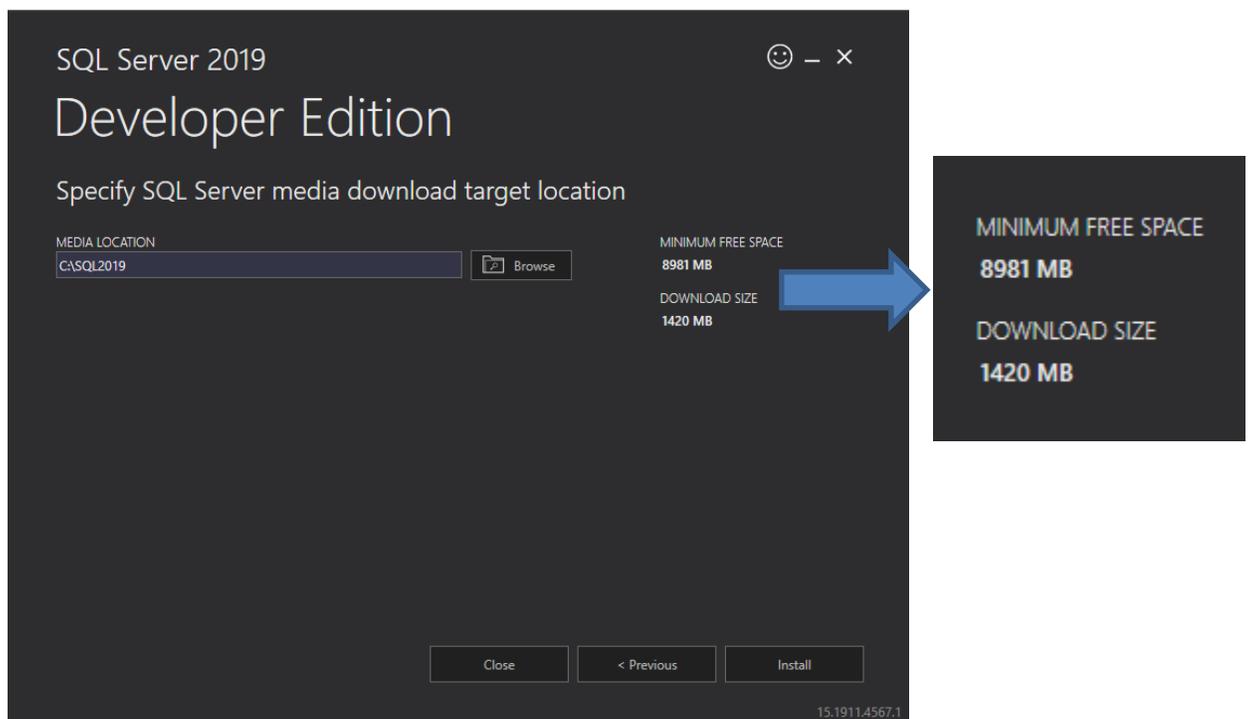
Click on the install file to begin the install process.

Installing SQL Server Developer Edition

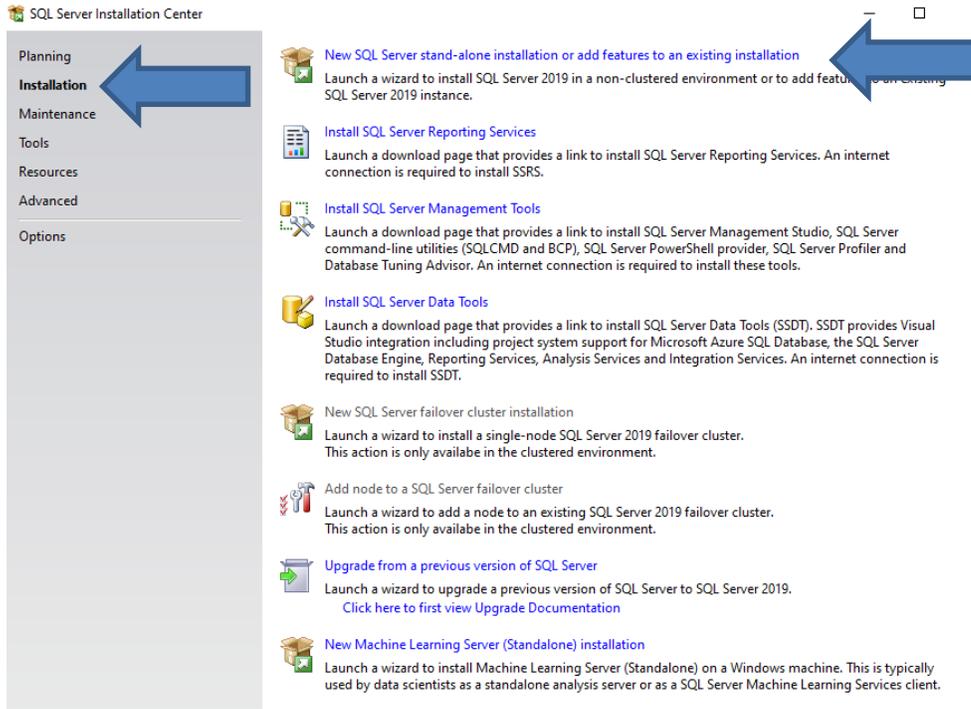
1. Once the installation starts, you will be presented with installation type. We will focus on the **Custom** install and explain various features of the installation.



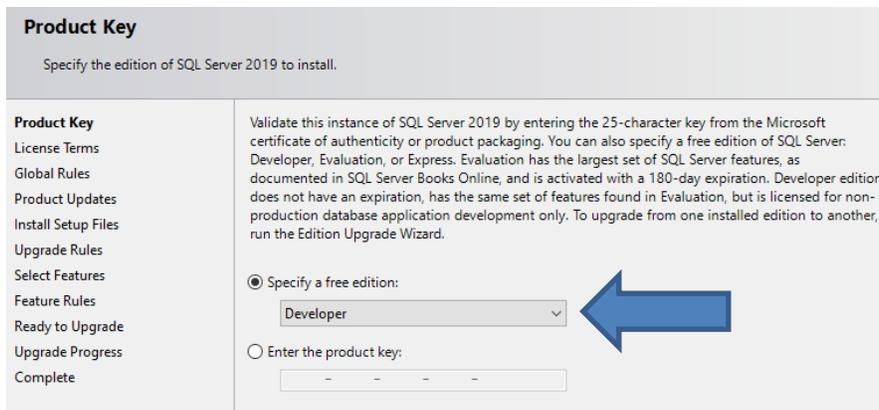
2. Choose the **Media Location** path. Note the minimum free space and download size and press **Install**.



- Once the SQL Server Installation Center launches choose **Installation** tab (second from the right).
- In most cases you will want to run a **New SQL Server New SQL Server stand-alone installation**, but other options are available, for example if you have a previous version of SQL Server installed, you have an option to update.



- On the Product Key page make sure that the selected Edition is “**Developer**” click *Next*.



- On the License Terms page, check the box next to “*I accept the license terms*” and click *Next*.
- Setup will check if needed install Setup Support Files. Click **Next** when complete.

Feature installation:

8. Select the components of SQL server to install on your computer.

Select **Database Engine Services**, this is the minim requirement to use SQL Server

Feature Selection
Select the Developer features to install.

Product Key
License Terms
Global Rules
Product Updates
Install Setup Files
Install Rules
Feature Selection
Feature Rules
Instance Configuration
Server Configuration
Database Engine Configuration
Feature Configuration Rules
Ready to Install
Installation Progress
Complete

Looking for Reporting Services? [Download it from the web](#)

Features:

Instance Features

- Database Engine Services
- SQL Server Replication
- Machine Learning Services and Language Extensions
 - R
 - Python
 - Java
- Full-Text and Semantic Extractions for Search
- Data Quality Services
- PolyBase Query Service for External Data
 - Java connector for HDFS data sources
- Analysis Services

Shared Features

- Machine Learning Server (Standalone)
 - R
 - Python
- Data Quality Client
- Client Tools Connectivity
- Integration Services
 - Scale Out Master
 - Scale Out Worker
- Client Tools Backwards Compatibility
- Client Tools SDK

Select All Unselect All

Instance root directory: C:\Program Files\Microsoft SQL Server\

Shared feature directory: C:\Program Files\Microsoft SQL Server\

Shared feature directory (x86): C:\Program Files (x86)\Microsoft SQL Server\

Feature description:
Includes the Database Engine, the core service for storing, processing and securing data. The Database Engine provides controlled access and rapid transaction processing and also provides rich support for sustaining high availability. The Database Engine also provides support for the utility control point in the SQL Server Utility. Only Database Engine Services and Analysis Services can be clustered.

Prerequisites for selected features:
Already installed:
Windows PowerShell 3.0 or higher
Microsoft Visual C++ 2017 Redistributable

Disk Space Requirements
Drive C: 1003 MB required, 19566 MB available

< Back Next > Cancel

- For CS779 in addition to what is listed above please review these descriptions to see which features you might be interested in for advanced topics for the term project.
- Instance root Directory and Shared Features Directory: Note the paths where SQL server will install the components (default is Program Files folder within C drive.)

Instance Configuration

9. Generally, you can leave the Default Instance and the default Instance ID. The Named instances would be used if you want to create multiple instances of SQL Server on the same machine. Click Next when complete.

Instance Configuration

Specify the name and instance ID for the instance of SQL Server. Instance ID becomes part of the installation path.

Product Key
License Terms
Global Rules
Product Updates
Install Setup Files
Install Rules
Feature Selection
Feature Rules
Instance Configuration
Server Configuration
Database Engine Configuration
Feature Configuration Rules
Ready to Install
Installation Progress
Complete

Default instance 

Named instance:

Instance ID:

SQL Server directory: C:\Program Files\Microsoft SQL Server\MSSQL15.MSSQLSERVER

Installed instances:

Instance Name	Instance ID	Features	Edition	Version
---------------	-------------	----------	---------	---------

< Back Next > Cancel

Server Configuration

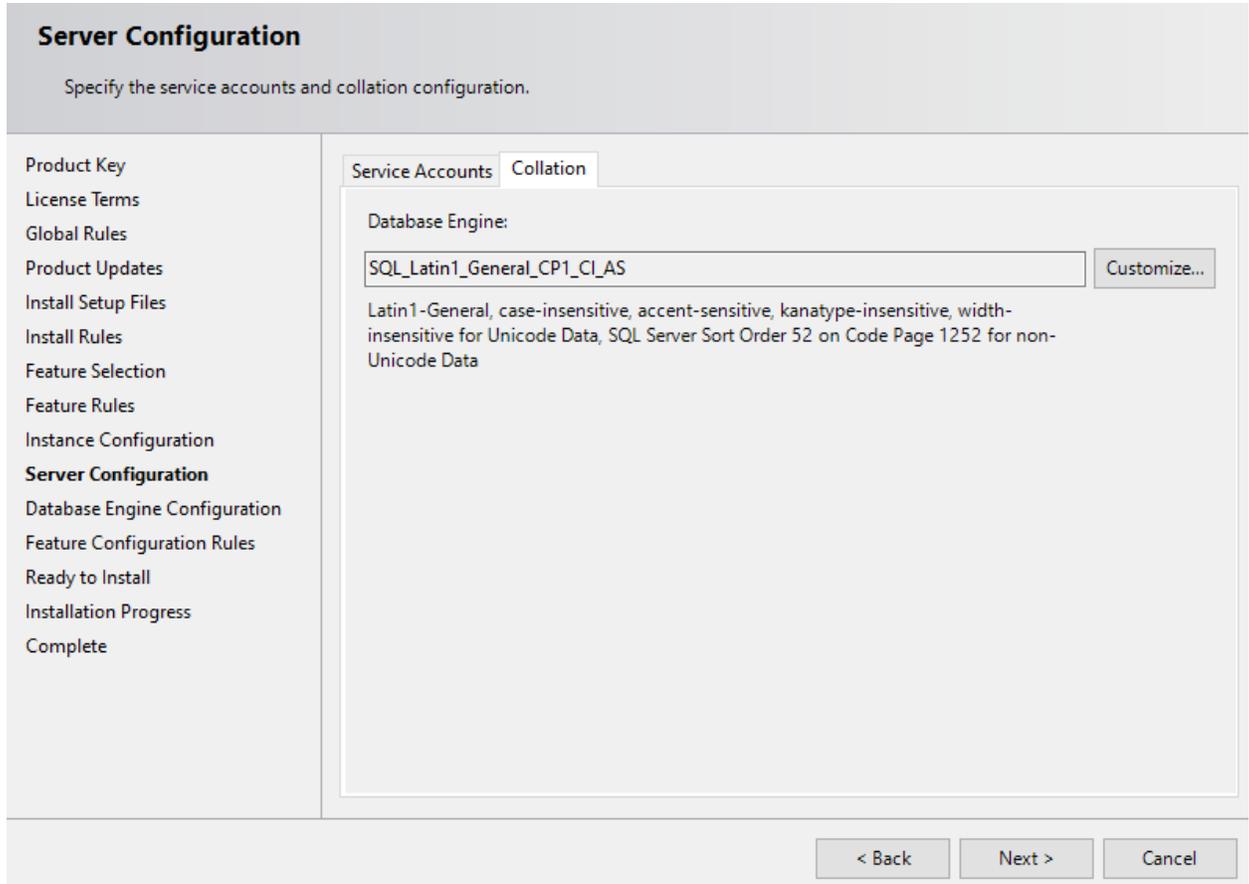
10. Review Server Configuration options.

- a. Account Names: We suggest that you leave these set to defaults provided by the installer as outlined below.
- b. Startup types: If you would like to have SQL Server running at all times on your computer, the Startup Type should be Automatic (which is the default) otherwise you can set it to Manual and start it when you need to use SQL Server so that it does not take up system resources such as RAM. Leave the other services to default (Manual & Disabled).

Service	Account Name	Password	Startup Type
SQL Server Agent	NT Service\SQLSERVERA...		Manual
SQL Server Database Engine	NT Service\MSSQLSERVER		Automatic
SQL Server Browser	NT AUTHORITY\LOCAL ...		Disabled

- A few additional detailed explanations:
 - c. **SQL Server Agent** is used for running scheduled jobs, such as backups, scheduled SQL scripts and db maintenance. If this was a production environment you would want this service set to automatic.
 - d. You will need **SQL Server Database Engine** to run SQL Server. Since DBMS uses a lot of system resources, we would recommend running it manually when you need it.
 - e. If you installed other components for SQL Server for advanced topics, you should also set them to manual so that they don't run on system startup.
 - f. SQL Server Browser can be left disabled.

- g. You do not need to select Grant Perform Volume Maintenance Task privilege to SQL Server for the course, however if performing installs in production environments this is recommended for data confidentiality. Note the link on the page for additional details.
- h. Check the collation tab at the top. For our purposes this can be left at default, SQL_Latin1_General_CP1_CI_AS, which is Latin1-General case insensitive accent sensitive. Collation defines the sorting rules, case and accent sensitivity for character data, for example you can choose a different language or set it to be case sensitive. Some applications require for you to choose a specific collation. You can click *Customize* to change it. Click *Next* when done.



Database Engine Configuration

Server Configuration:

- Authentication mode:
 - Windows authentication: will only use your windows account privileges to connect to SQL Server.
 - Mixed mode: adds a local SQL system administrator (SA) account
IMPORTANT: We highly recommend using **Mixed Mode** so that there is an additional built in SA account with a separate user name and password as well as your built-in windows account in case you have issues logging in.
- **IMPORTANT:** Make sure to add users (such as your account) to SQL Server Administrators (click on **Add Current User**) if it is not already there.
- These accounts will allow you to log into SQL Server.
- Note that the server itself does not need these accounts and runs as a service which you specified in previous step.

Database Engine Configuration

Specify Database Engine authentication security mode, administrators, data directories, TempDB, Max degree of parallelism, Memory limits, and Filestream settings.

Product Key
License Terms
Global Rules
Product Updates
Install Setup Files
Install Rules
Feature Selection
Feature Rules
Instance Configuration
Server Configuration
Database Engine Configuration
Feature Configuration Rules
Ready to Install
Installation Progress
Complete

Server Configuration | Data Directories | TempDB | MaxDOP | Memory | FILESTREAM

Specify the authentication mode and administrators for the Database Engine.

Authentication Mode

Windows authentication mode

Mixed Mode (SQL Server authentication and Windows authentication)

Specify the password for the SQL Server system administrator (sa) account.

Enter password: [password]

Confirm password: [password]

Specify SQL Server administrators

SQLSERVER-PC\User (User)

SQL Server administrators have unrestricted access to the Database Engine.

Add Current User | Add... | Remove

< Back | Next > | Cancel

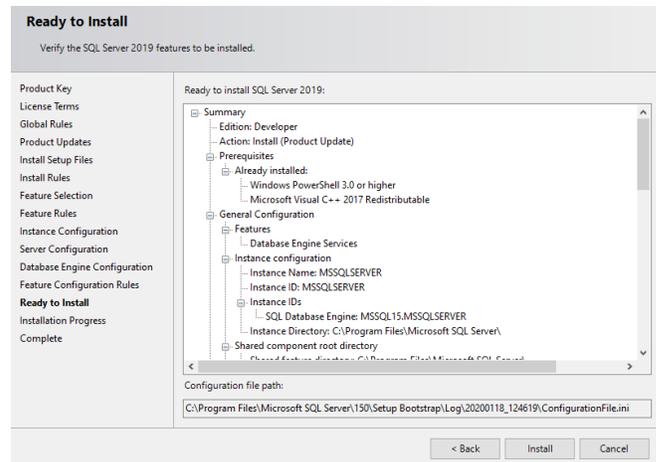
- A few additional detailed explanations:
 - a. You can leave Data Directories to defaults. Data Directories can be changed if you have a multiple disk environment and for performance want to separate out where

different parts of the DBMS go. For example, in production environments the LOG components should go on a separate disk array, which will improve performance of the system.

- For additional tuning you can explore the TempDB, Max Degree of Parallelism and Memory settings. TempDB system database used by SQL Server. For additional details please review the following link: <https://msdn.microsoft.com/en-us/library/ms190768.aspx> As an example, this page allows you to customize auto-growth settings for the TempDB. For the courses leaving the defaults is fine.
- If you are installing SQL Server for CS779 you might want to enable FILESTREAM if you plan to explore large file types such as Binary language objects (BLOB). As with many other features, this can be enabled at a later time.

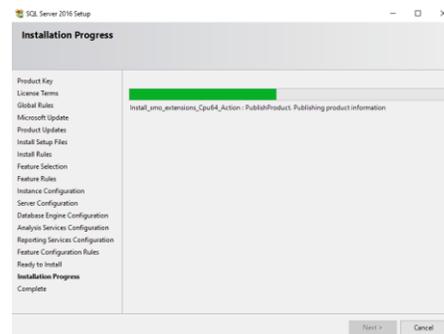
Error Reporting, Installation Configuration Rules, & Ready to Install

- Review selected features and click **Install**, Installation will begin, this will take some time.



- This will take some time

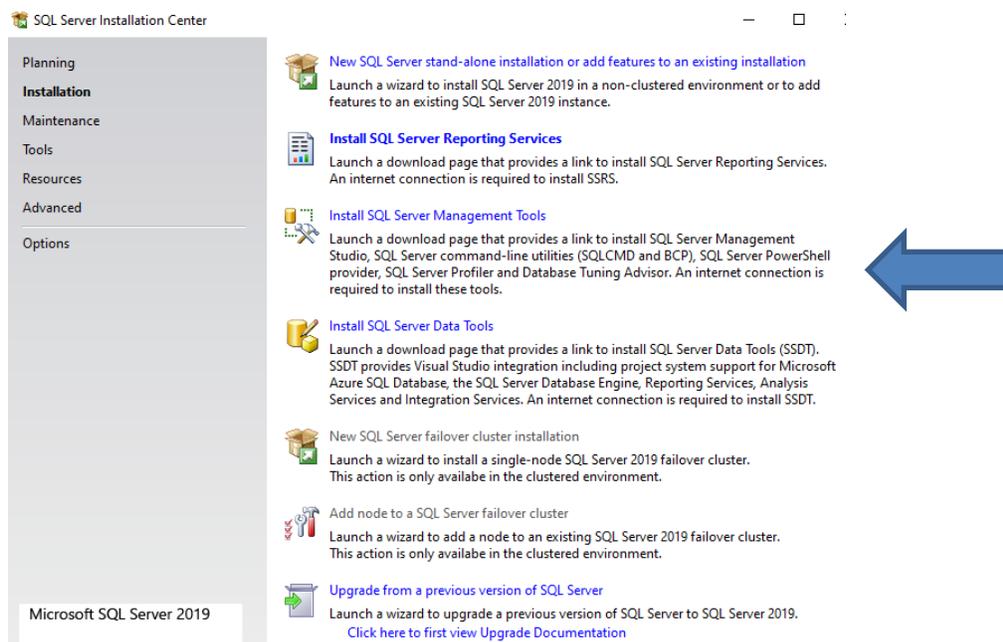
- Once the installation is complete Congratulations SQL Server Install is complete, click close.



SQL Server Management Tools

You will need SQL Server Management Tools to work with SQL Server, this is the user interface that include components such as the Query interface as well as components for advanced topics such as analysis and integration services as well as the database tuning advisor. SQL Server, like other modern relational databases, uses a client-server architecture. The database itself is the server and contains all of the data and the capability to add, modify, delete, and access the data. A client is needed to connect to the database and perform specific commands. The most popular client by far for SQL Server is SQL Server Management Studio (SSMS), which you will install in this section. SSMS is very capable and provides many powerful conveniences and capabilities.

It is required that you install the Management Tools Complete for all courses.



The screenshot shows the SQL Server Installation Center interface. On the left is a navigation pane with categories: Planning, Installation, Maintenance, Tools, Resources, Advanced, and Options. The 'Installation' category is selected. The main area lists several installation options:

- New SQL Server stand-alone installation or add features to an existing installation**: Launch a wizard to install SQL Server 2019 in a non-clustered environment or to add features to an existing SQL Server 2019 instance.
- Install SQL Server Reporting Services**: Launch a download page that provides a link to install SQL Server Reporting Services. An internet connection is required to install SSRS.
- Install SQL Server Management Tools**: Launch a download page that provides a link to install SQL Server Management Studio, SQL Server command-line utilities (SQLCMD and BCP), SQL Server PowerShell provider, SQL Server Profiler and Database Tuning Advisor. An internet connection is required to install these tools. **←**
- Install SQL Server Data Tools**: Launch a download page that provides a link to install SQL Server Data Tools (SSDT). SSDT provides Visual Studio integration including project system support for Microsoft Azure SQL Database, the SQL Server Database Engine, Reporting Services, Analysis Services and Integration Services. An internet connection is required to install SSDT.
- New SQL Server failover cluster installation**: Launch a wizard to install a single-node SQL Server 2019 failover cluster. This action is only available in the clustered environment.
- Add node to a SQL Server failover cluster**: Launch a wizard to add a node to an existing SQL Server 2019 failover cluster. This action is only available in the clustered environment.
- Upgrade from a previous version of SQL Server**: Launch a wizard to upgrade a previous version of SQL Server to SQL Server 2019. [Click here to first view Upgrade Documentation](#)

At the bottom left, it says 'Microsoft SQL Server 2019'.

Download SQL Server Management Studio (SSMS)

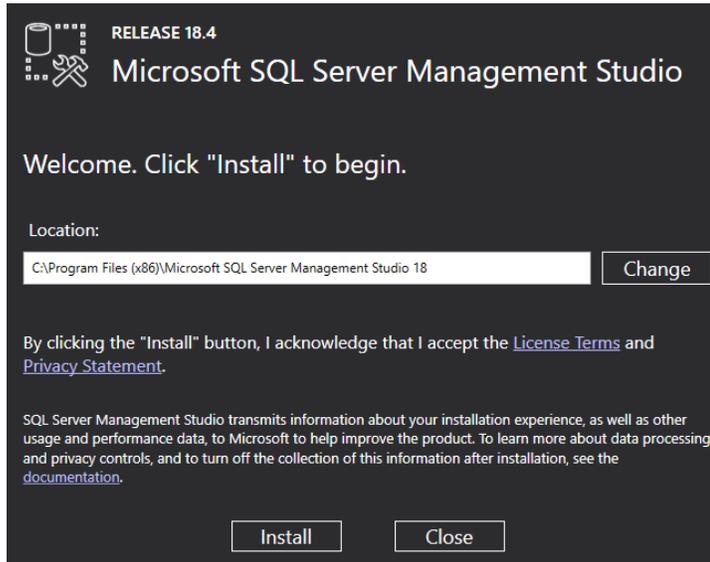
You will be brought to a web page to download the latest release of SQL Server Management Studio. Click on the link to download the latest release and save the file to a location you can remember.

Download SSMS

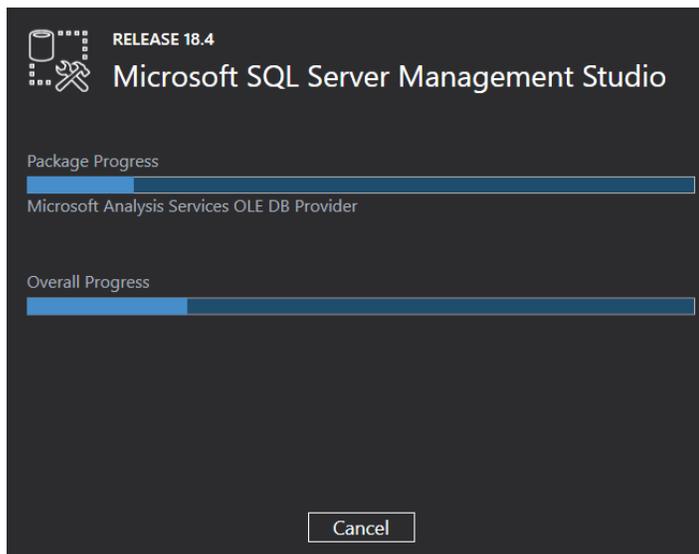
 [Download SQL Server Management Studio \(SSMS\)](#)

Install SQL Server Management Studio (SSMS)

Once downloaded, run the SSMS installer. The first screen that appear is shown below.



Click the “Install” button to begin. A progress screen will appear similar to the following.



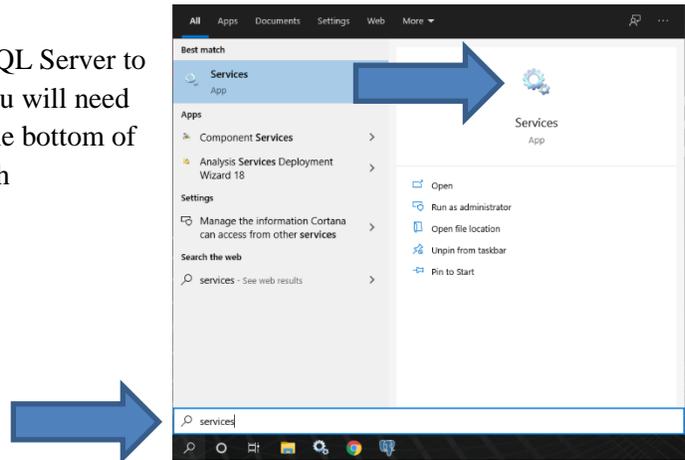
Let it progress through until completion, then you will see a screen indicating successful setup, click close. Congratulations! SSMS is now installed.

Working with and connecting to SQL Server

You have installed both SQL Server and SSMS. There are just a few more steps you need in order to start using your database to complete assignments -- connecting to your database and creating a database for assignments.

Starting & Stopping SQL Server (optional)

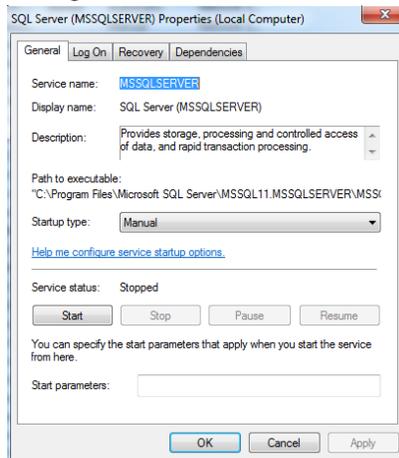
IMPORTANT: If during setup you selected for SQL Server to **start manually** (see page 10 of this guide) then you will need to start SQL Server services. Click on Search at the bottom of the Windows screen and type in **Services** in the search



- Scroll down the list until you see the SQL Server services.

	SQL Server (MSSQLSERVER)	Provides sto...	Manual
	SQL Server Agent (MSSQLS...	Executes jo...	Manual
	SQL Server Browser	Provides SQ...	Disabled

- Start the following service: SQL Server (Instance Name)



- SQL Server service should now show that it is running.

	SQL Server (MSSQLSERVER)	Provides sto...	Running	Manual
	SQL Server Agent (MSSQLS...	Executes jo...	Manual	Manual
	SQL Server Browser	Provides SQ...	Disabled	Disabled

Notes:

- When you are no longer using SQL Server, you can shut the service down to save on system resources.
- You can also change the startup type to be automatic while the course is running to save you the step of turning this on and off.
- You may want to put the services shortcut to your desktop for quick access

Starting SQL Server Management Studio

- To work with SQL Server, you will use the **SQL Server Management Studio**. You will find it under Microsoft SQL Server Tools program group or type in in the Windows Search bar.

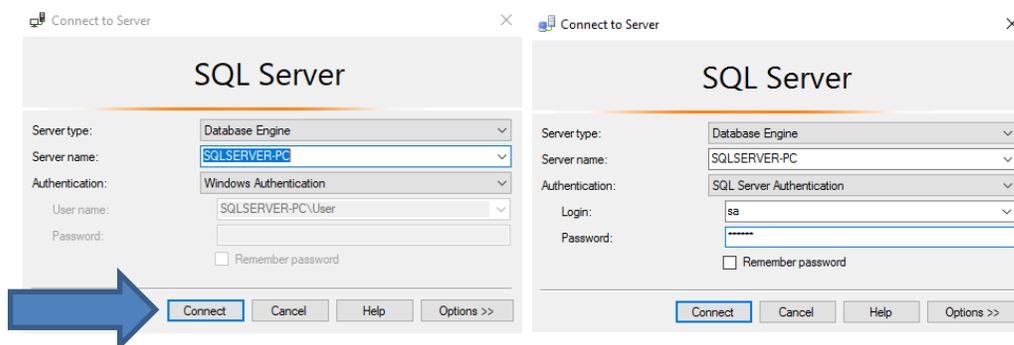


Microsoft SQL Server Management Studio 18
App

- You may want to put the SQL Server Management Studio shortcut to your desktop or pin it to the Windows Task bar for quicker access.

Connecting SQL Server

- In the Connect to Server dialog box:
 - Server Type: Database Engine (default)
 - Server Name: This is your system name (default).
 - Authentication: Use
 - Windows Authentication (default) and your account
 - OR
 - The SQL Server Authentication with Login: SA and password which you created during the install and click **Connect**.



You have just connected to your database through SQL Server Management Studio!

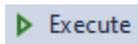
Using SQL Server Management Studio

Overview of SQL Server Management Studio

Once you connect to SQL Server Instance you can begin to create a database, write queries, or explore the database. Below is a very quick overview of the SQL Server Management Studio Interface to get you started.

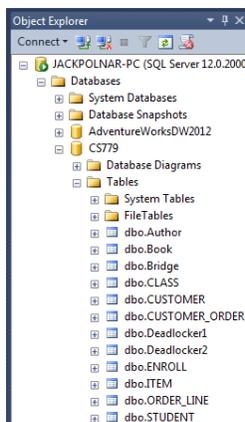
 Saves your SQL commands as .SQL files.

 **New Query** Creates a new query window for you to type your SQL commands.

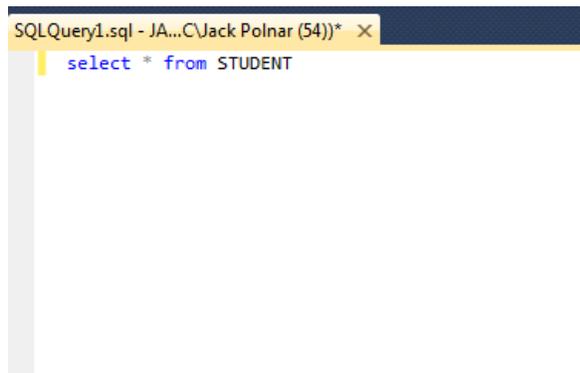
 **Execute** Runs your SQL commands.

 **CS779** Dropdown to select the database you are working with.

IMPORTANT: Make sure not to work in the master database.



Object Explorer allows you to browse databases, tables, columns and other objects within the database.



Query window where you can type in your SQL query commands.

	STU_NUM	STU_NAME
1	1	Jack
2	2	Bob
3	3	Chris
4	4	Valencia, Xanthus S.
5	5	Blevins, Porter Y.
6	6	Schultz, Hakeem A.
7	7	Waller, Jayme E.
8	8	Wiggins, Amber T.
9	9	Mercado, Cathleen M.
10	10	Ball, Dominique A.
11	11	Walls, Sophia Z.
12	12	Allison, Nigel L.
13	13	Everett, Lewis C.
14	14	Dodson, Tatum Z.
15	15	Acosta, Macon C.

(12.0 RTM) | JackPolnar-PC\Jack Pol... | CS779 | 00:00:00 | 204 rows

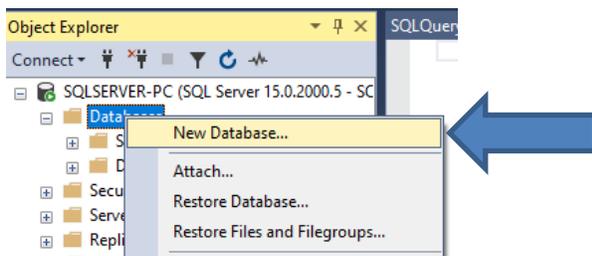
SQL Query results. Note how the execution time and number of rows are at the bottom.



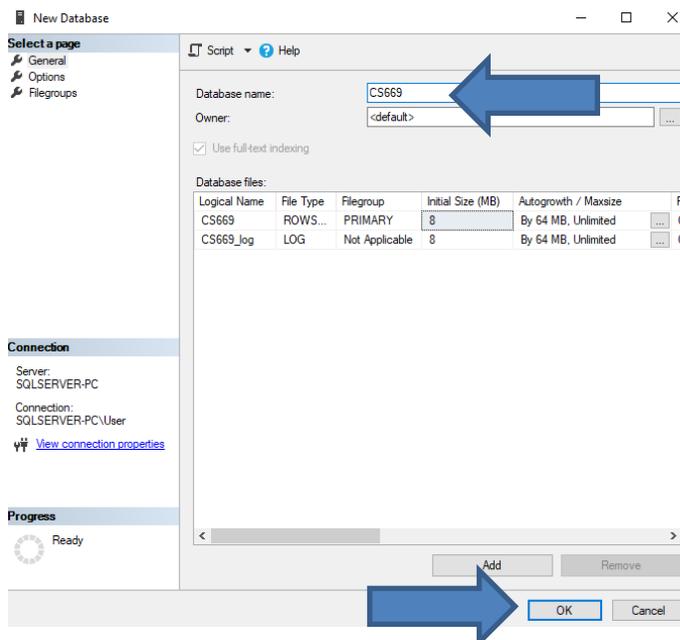
Creating a Database

You are almost ready to begin working on assignments, but one more step is needed: creating a database. Now to be sure, there is already a default database called “master”, but it is perilous to use that database for anything of substance. Master is a system database which contains information about the server’s configuration; that database is critical to the operation of SQL Server itself, and if it gets corrupted, or runs out of space, the entire SQL Server instance is at risk. System databases are often located on drives with limited space, and if we need to fail over our instance to another instance, we cannot usually restore the master itself since each instance has its own configuration. Suffice it to say, for assignments it is prudent to create another database.

To get started, first right-click on **Databases** in the Object Explorer and click **New Database...** from the context menu, as illustrated below.

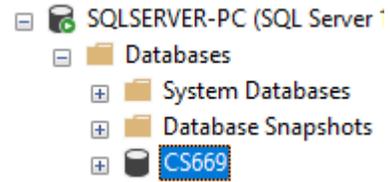


When the New Database window appears, enter a database name, and leave everything else defaulted. In the screenshot below, we can use **CS669** as the database name, though you can use something different if you would like.

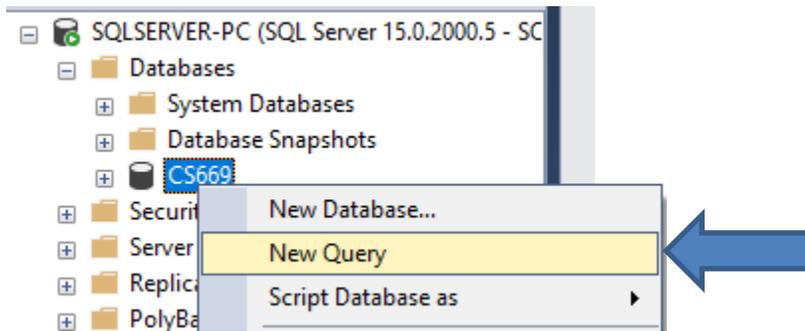


Then click the OK button to create the database. The window will process for a moment, then disappear.

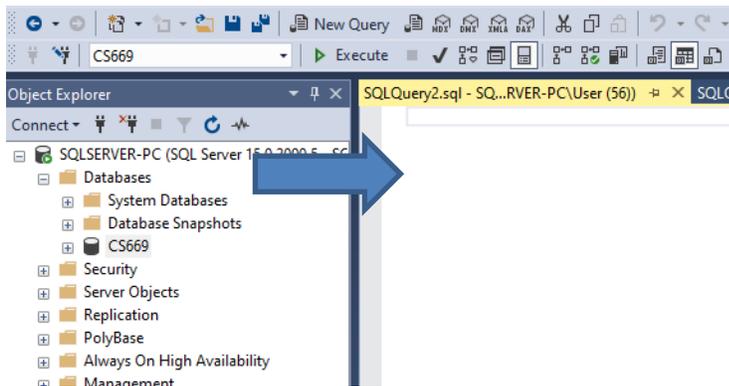
Next, in the Object Explorer, expand **Databases** and locate your new database.



Right-click on **CS669** database and select **New Query**, as illustrated.

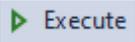


A new query window appears, where commands can be typed, saved, and executed. The window is illustrated next.

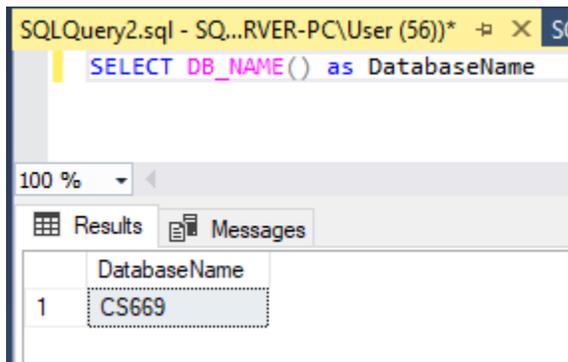


All your assignment's commands can be typed and executed in this type of query window! Let's execute a single SQL command to verify that the database is running. In the buffer, type

```
SELECT DB_NAME() as DatabaseName
```

and then click the **Execute**  button just above. You may alternatively hit the F5 key to execute the command.

You should see the results something like this:



Notice that the results listed out our database name, CS669. There are of course many more commands that you will use in your course, but this gets us started. When you complete your assignments, you will use a query window just like this, type in your commands, and execute them to get your results.

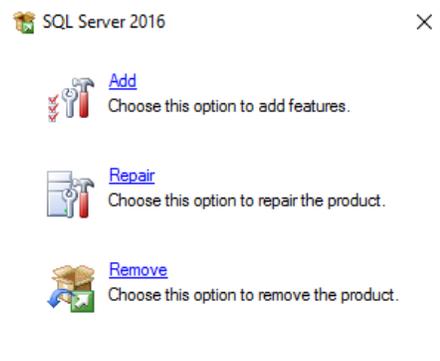
Congratulations! You have installed SQL Server and its client, connected to your database, and executed a command. You are now ready to complete assignments for your course!

Uninstall SQL Server or Change Features

If you no longer need to use SQL Server, or would like to re-install it or change feature, you can use these steps to uninstall SQL Server from your system.

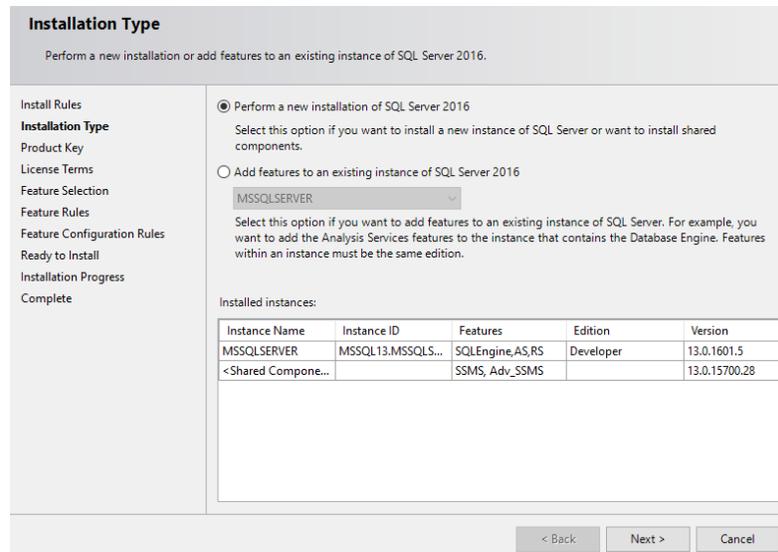
Uninstalling SQL Server

1. Go to Windows Settings and Apps
2. Sort program list by name.
3. Look for Microsoft SQL Server and double click on it.
4. Choose *Remove*
5. SQL Server will gather information that it needs to perform the uninstall. This will take some time.
6. When prompted to **Select Features**, *Select All* and click *Next*.
7. **Removal Rules** will process, click *Next*.
8. **Ready to Remove** will give you a summary, click *Remove*.
9. Once finished SQL Server is removed. You may want to review Windows Settings and Apps to make sure no components have been left behind however be careful not to remove any Windows SQL Server components such as Windows Compact Edition. If you are not sure, you can leave these as is.



Change SQL Server Features and Components

1. Go to Windows Settings and Apps
2. Sort program list by name.
3. Look for Microsoft SQL Server and double click on it.
4. Choose *Add*.
5. You may be prompted to select the SQL Server media location. (i.e. your DVD drive)
6. SQL Server will gather information that it needs to modify components and check Install Setup files. This will take some time. Click *Ok* or *Next* when prompted.
7. When prompted to **Select Installation Type**, choose *Add features to an existing instance of SQL Server 2016* and click *Next*



8. When prompted for **Feature Selection**, review and update features, review Feature list in the installation instructions in previous sections, and click *Next*.
9. You will be prompted to verify Installation Rules, Disk Space Requirements, Error Reporting, and Installation Configuration Rules, click *Next*.
10. **Ready to Install** will give you a summary, click *Install*.

Appendix: How to Install SQL Server on a Mac

SQL Server can be installed and used on a Mac, but this requires some setup work. Many consider Mac computers to be the most user friendly computers available, and there are many devoted Mac users today. Although Mac computers may be user friendly, the Mac platform is not supported by the major, modern DBMS vendors, including Oracle and SQL Server. If you find yourself in the situation where your home computer is a Mac, and you do not have a readily available Windows machine available for DBMS installation, there are two ways to run Windows on your Mac – dual booting and using a virtual machine.

Dual Booting

The first solution, dual booting, is available to you if you have a modern Mac that runs on an Intel-based processor. All new Macs run on Intel-based processors, but older ones do not. Dual booting is a fairly simple concept. Normally when you power on your computer, your operating system starts booting immediately, and this happens seamlessly so that it appears your operating system is just a natural part of the computer. In actuality, when your computer is first powered on, it first loads a boot loader program, and that boot loader tells the operating system to start. If there is only one operating system, you may not even notice the work of the boot loader, because it always starts the same operating system. However, there is no reason why one cannot install two operating systems on their computer. In such a case, each time your computer is powered on, the boot loader asks you which operating system you would like to start, and also usually defaults to the first one if you do not select an option, after a timeout period.

All Macs come with what Apple terms “Boot Camp”, which is a built-in utility that supports dual booting Mac OS X and Windows. To install SQL Server in Windows on your Mac, you will need to:

1. Review the prerequisites needed to run Boot Camp and to install Windows as a second operating system on your Mac computer. The prerequisites are listed at <http://support.apple.com/kb/HT1461>. Ensure that your computer meets the requirements before continuing.
2. Obtain a licensed copy of Windows. If you do not have a licensed copy of Windows, you will need to download one from the Microsoft Azure BU site. BU students are entitled to free, licensed copies of the latest versions of Windows through the site, and details on how to access this site are available in your course’s syllabus.
3. Follow the steps recommended by Apple to install Windows using Boot Camp. Instructions are included with the utility, and you can also start here as well: <http://support.apple.com/kb/HT1461>
4. After Windows is installed, reboot your computer then boot into Windows. Proceed with the SQL Server install instructions, starting from the beginning of this install guide. When you need to run SQL Server, boot into Windows.

Using a Virtual Machine

A virtual machine mostly behaves as any other application, but has some differences. The virtual machine has an application window that can be minimized and closed, the same as any other application. What makes a virtual machine different from an ordinary application is that an entire operating system is installed and executes inside of the virtual machine. The operating system running inside of the virtual machine, termed a “guest” operating system, runs as if it were to be on its own physical machine. This means we can install and use applications native to the guest operating system. Thus, once we are running a virtual machine, we are effectively running two operating systems at the same time – our machine’s operating system (termed the “host” operating system), and the guest operating system – and are using applications native to both operating systems at the same time.

In our case, we are interested in running Windows as a guest operating system on our Mac. There are many virtual machines available for Macs; however, perhaps the two most popular are VirtualBox and Parallels. VirtualBox, available at <http://virtualbox.org>, is free to download and use. Students have successfully used both to run both Windows and SQL Server on a Mac in our BU program.

Follow the steps below to install and use SQL Server on your Mac:

1. Download and install your virtual machine of choice.
2. Obtain a licensed copy of Windows. If you do not have a licensed copy of Windows, you will need to download one from the Microsoft Azure BU site. BU students are entitled to free, licensed copies of the latest versions of Windows through the site, and details on how to access this site are available in your course’s syllabus.
3. Install Windows inside of the virtual machine.
4. Proceed with the SQL Server install instructions, starting from the beginning of this install guide, installing SQL Server into the guest operating system.

Dual Booting Versus Using a Virtual Machine

An obvious question is, which of these two options should you use? The answer depends upon your computer hardware, and your personal preferences. The following table summarizes the advantages of both options.

	Advantages	Disadvantages
Dual Booting	<p>Because both operating systems run natively on the computer's hardware, there is no performance overhead.</p> <p>Because both operating systems directly access the computer's hardware, there are not hardware compatibility issues.</p> <p>The setup is conceptually simpler. Simply boot the operating system you need upon startup.</p>	<p>You can only run one operating system and its applications at a time.</p> <p>To start the second operating system, you must reboot.</p> <p>There is no clipboard sharing between applications in both operating systems. If text is to be shared across applications, it must be saved in a file then loaded by applications in the other operating system.</p>
Virtual Machine	<p>The guest operating system and its applications run at the same time as the host operating system and its applications.</p> <p>There is clipboard sharing between applications in both operating systems. Text can be copied from an application in one operating system, and pasted into an application in the second operating system.</p>	<p>Because the guest operating system is running under the control of virtual machine software, the guest operating system and its applications will execute noticeably slower than if they were running natively on the computer.</p> <p>Because both operating systems run concurrently, the performance of the host operating system may degrade.</p>

If your hardware is powerful enough to support running two operating systems simultaneously, and still perform reasonably well, you may want to use a virtual machine, so that you can run both your Mac applications and your Windows applications at the same time. If you are concerned about obtaining the best performance for both operating systems, you may want to dual boot.