

Tools to use in an information technology class – and best of all they are FREE!

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Introduction

Purdue Polytechnic has several locations in the state of Indiana offering students a chance to get a Purdue degree. The Computer and Information Technology (CIT) department offers the CIT degree at three sites in Indiana: Anderson, Columbus and Kokomo. CIT offers several potential majors including Cybersecurity, Network Engineering, Systems Analysis. At the Columbus site we offer the Computer & Information Technology major. This major is a general degree that would have a variety of CIT offerings in all of the majors mentioned. Each statewide site of Purdue Polytechnic has multiple labs including approximately 30 throughout the state (including labs used for CIT and other programs) that must be maintained with an annual budget of approximately \$200,000 for hardware and software. In the general CIT major, students take up to 15 courses that have lab component and require from general software like Microsoft Office to more specialized software such as Unity Pro and Autodesk Maya that are used in our game development class. Our classes focus on four areas: networking, programming, systems analysis and programming. We have purchased a variety of licenses to use in these tasks. With a limited budget we are always looking for viable alternatives. In this paper we will review some options that we have incorporated or plan to incorporate into our labs. In our search we were looking for low cost or no cost options. The best news is all of the options we will discuss in this paper are free. The following pages discuss the products we found.

VirtualBox

VirtualBox is a category of virtual machine software or VM that can provide the user an emulation of a particular computer that the user can manage and use. This can be a complete substitute of real machine in which the user can install operating systems and other software of choice. VirtualBox was initially offered by Innotek GmbH which was bought out by Sun Microsystems and subsequently by Oracle Corporation and rebranded by the official name of Oracle VM VirtualBox. VirtualBox is free Open Source Software. On their website Oracle describes VirtualBox as “a powerful x86 and AMD64/Intel64 virtualization product for enterprise as well as home use. VirtualBox is an extremely

feature rich, high performance product for enterprise customers. Presently, VirtualBox runs on Windows, Linux, Macintosh, and Solaris hosts and supports a large number of guest operating systems including but not limited to Windows (NT 4.0, 2000, XP, Server 2003, Vista, Windows 7, Windows 8, Windows 10), DOS/Windows 3.x, Linux (2.4, 2.6, 3.x and 4.x), Solaris and OpenSolaris, OS/2, and OpenBSD as in Figure 1 shown with Fedora 21 running.”

Purdue University’s main campus has a site license for VMware which is also virtualization software. Both VMware and VirtualBox provide similar capabilities. In our case we are not looking to replace VMware but have VirtualBox as an additional option. There are several advantages for our students to use VirtualBox. The biggest advantage is that it is standalone, meaning that once installed the student does not need to be connected to the network to use. Although, connecting to a network is not generally a big issue it does make its use more portable. It does not require the student to set up a VPN or connect to a remote desktop as required by VMware. Another advantage is that with the Oracle purchase of VirtualBox they have provided pre-built virtual machines that already have the operating system and Oracle application software installed. Typically, these pre-built machines are tuned so that they run efficiently on a standalone PC. These pre-built virtual machines (appliances) are also free. There are several disadvantages of using VirtualBox. In order to run VirtualBox you need a reasonably powerful x86 hardware at least 2GB of RAM (more is better) and although VirtualBox does not require a lot of disk space (typically about 30MB) the virtual machines can grow significantly depending upon the operating system and software utilized. Finally, you need to be running one of the supported operating systems. Another negative of VirtualBox is that there is no local support if students have issues installing or using the software. Since VMware is located on Purdue servers, it does not require the student to have a powerful machine with any disk or memory requirements and is totally supported by the Purdue IT Support.

We currently use VirtualBox in CNIT 487 Database Administration. This is an upper level CIT class used as an introduction for students in the role of Database Administrator (DBA). The database software we use in the class is the Oracle DBMS. Virtualization is useful in this class because in order to manage an Oracle database students are required to have administrator privileges on the machine and Purdue support is justifiably unwilling to give students that capability in Purdue labs. Several years ago we started teaching an online version of this class. In the CNIT 487 course we use both VMware and VirtualBox for labs and class project. The VMware has Oracle installed in a Windows environment and VirtualBox utilizes a pre-built appliance that has been modified for the class using Linux. This has allowed students to use Oracle in multiple environments. In the time we have taught the class students have not had many real issues with using VirtualBox. I have created several tutorials including one on how to install VirtualBox and how to install an appliance that has eliminated some of the early issues we had in the class.

As mentioned VirtualBox is free and documentation and downloads can be accessed at : <https://www.virtualbox.org/> .

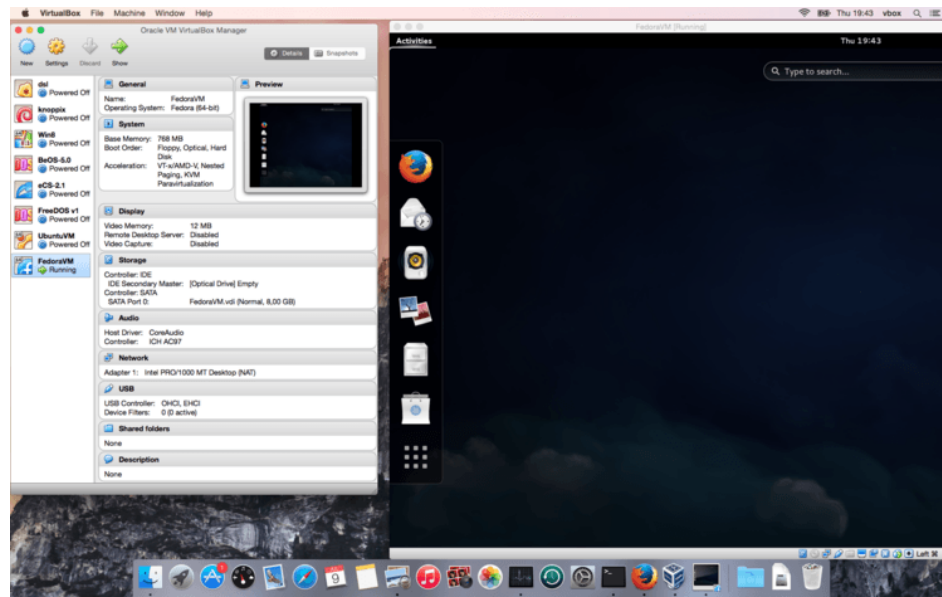


Figure 1. VirtualBox 5.0 for Mac OS X with VirtualBox Fedora 21 running

Oracle SQL Developer

SQL Developer is an Integrated Development Environment (IDE) that provides programmers and administrators with tools to automate many of the development functions. According to Oracle it can be used by developers, DBAs, Data Modelers and Web Application Developers and Administrators. It also has the capability to migrate many third party databases including Microsoft Access, SQL Server, Sybase ASE, DB2 or Teradata. The tool was developed by Oracle and is used on versions 10g, 11g, and 12c and can run on any operating system that runs Java. Specifically, SQL Developer provides an editor for working with SQL and PL/SQL allowing the developer to run queries and execute, debug and test program code. Newer versions of SQL Developer provide DBA capabilities to perform tasks such as backup/recovery, auditing, user management, and storage management. The tool is also compatible with the CASE tool SQL Developer Data Modeler (discussed later in the paper).

SQL Developer replaces SQL*Plus a command line interface from Oracle Corporation used to access Oracle databases from Oracle version 4 on up. It was shipped with the Oracle database until the release 11g when Oracle quit shipping the product with the Oracle database software. There are also third party products such as TOAD from Dell Software that is offered both freeware and commercial (running \$975 a seat on up). Oracle SQL Developer has many advantages over the previous product SQL*Plus which was strictly a command-line interface as opposed to the GUI interface provided by SQL Developer. The tool supports not only command line execution of SQL commands but has an editor to support development using PL/SQL language as shown in Figure 2. The product is an .exe file and requires no installation as opposed to SQL*Plus that required the user to install the Oracle client. This is not particularly important for lab machines but made use of the tool easier for students at home. TOAD has an advantage of being able to access multiple databases, but this is not a problem since Oracle databases are used in all classes except the introductory

class that uses Microsoft Access. If you have a valid license for Oracle software (Purdue does), then you also access to Oracle support for SQL Developer issues.

Oracle SQL Developer is installed in all of the statewide labs that have CIT programs and used by most students that want to access the Oracle server with their personal computers. We use Oracle SQL Developer in three classes CNIT 272 Database Fundamentals, CNIT 372 Database Programming and CNIT 392 Enterprise Data Management. We have been using the product for several years now. Students using the product at home have said that it is easier to use than SQL*Plus. The only real issue we have had was a performance issue when we installed a newer version in our labs.

Oracle SQL Developer is a free product and can be accessed at: <https://www.oracle.com/downloads/index.html>.

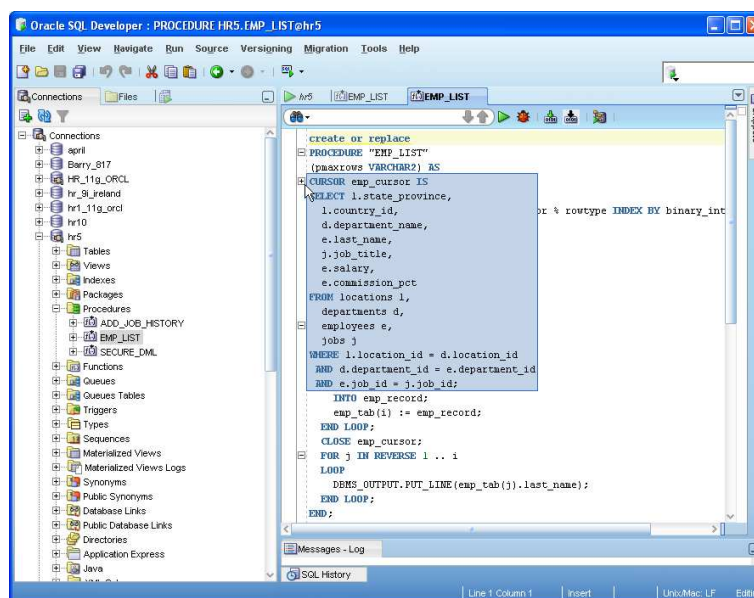


Figure 2. SQL Developer with PL/SQL code

Oracle SQL Developer Data Modeler

SQL Developer Data Modeler or Data Modeler is part of SQL Developer or a standalone product (what we will discuss in this paper). Data Modeler is a graphical tool that can be used to create and maintain logical, relational (as shown in Figure 3) and physical models. The main model used in database design is an Entity Relationship Diagram (ERD). Data Modeler supports development of ERDs using both the Bachman and Barker notation. Besides creating and maintaining Entity Relationship Diagrams (ERDs) the tool can be used to forward and reverse engineer databases. The tool can also be used to develop process models – Data Flow Diagrams (DFDs). Data Modeler can be used in a standalone and in Cloud environments.

Oracle SQL Developer Data Modeler replaces two tools Oracle Designer and Microsoft Visio. Oracle Designer was a tool from Oracle Corporation that contains many of the same features as Data

Modeler. Data Modeler like SQL Developer requires no installation because it is an .exe file that only requires an operating system that can use Java. That is the biggest advantage of Data Modeler over Designer. Designer was difficult to install in the labs and support and most students didn't bother to try and install it at home. It also tended to run very slow and if more than a few users were on it ran extremely slow. Visio is still used on lab machines (mainly in systems classes) because it has the advantage of including not only ERDs but also able to model in UML including Class Diagrams, Use Cases, Sequence Diagrams along with Data Flow Diagrams (DFDs). A disadvantage of Visio is that students have to buy it because it is not included in any agreements between Purdue and Microsoft Corporation, unlike Oracle Data Modeler which is free for students to download.

Oracle SQL Developer Data Modeler is installed in all of the statewide labs that have CIT programs and used by most students that want to access the Oracle server with their personal computers. We use Oracle SQL Developer Data Modeler in three classes CNIT 272 Database Fundamentals, CNIT 372 Database Programming and CNIT 392 Enterprise Data Management. Students have been using the product for several years and have not had any major complaints (which were common with Oracle Designer).

Oracle SQL Developer Data Modeler is a free product and can be accessed at: <https://www.oracle.com/downloads/index.html>.

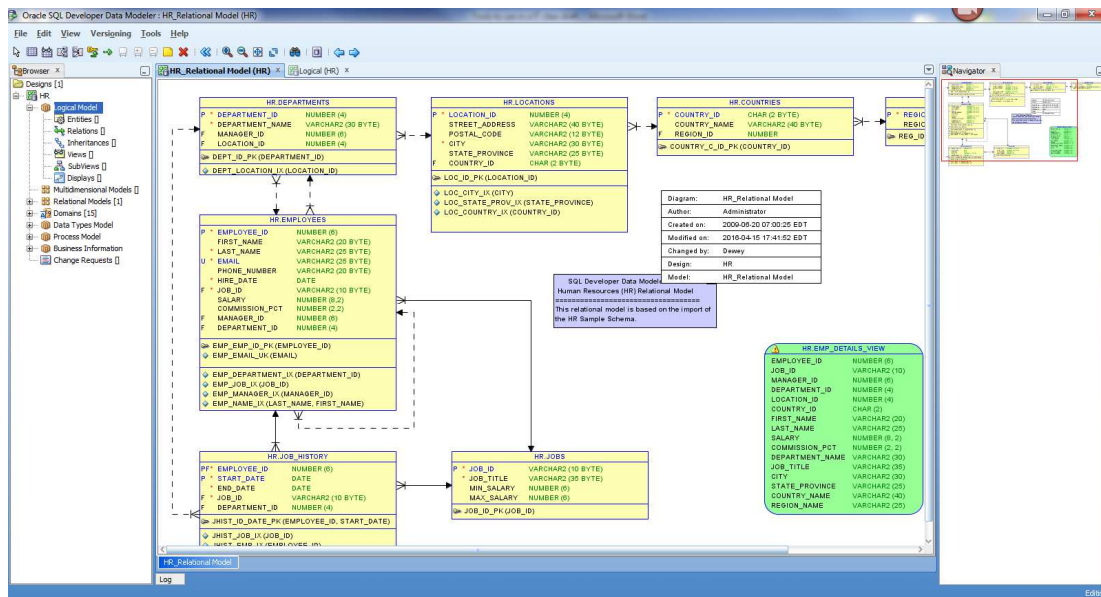


Figure 3. SQL Developer Data Modeler with relational model

GameMaker: Studio

GameMaker: Studio is a 2D game engine developed by YoYo Games, a company founded in Dundee, Scotland. In 2015, the company became a subsidiary of Playtech, a gambling software development company with headquarters on the Isle of Man. It was sold to PlayTech for £10.65 million, a sum approximately equivalent to \$16.4 million at the time of the purchase. A screenshot of a simple 2D game

made using GameMaker: Studio and run in the debug mode under the auspices of the IDE is shown in Figure 4. The game took 45 minutes to make.

This tool can be used to replace the 2D game development functionality of Unity 5 in our pilot CNIT 399 Introduction to Game Development course that is scheduled to be offered for the second time in the Fall of 2016. (The course was taught for the first time by one of the authors in Spring 2015.) In addition to offering a free version, GameMaker: Studio has the advantage of providing an intuitive Drag and Drop system that makes the learning curve less steep and allows a student to quickly put together 2D games of such common genres as mazes and platformers. Presenting a mild disadvantage, the scripting for this game engine has to be done in a special scripting language called GML (GameMaker Language) based on C. Unity 5 allows scripting in C#, a language that our undergraduate students would have programmed in for at least two semesters prior to taking the pilot course. On the positive side, unlike C#, GML supports the aforementioned Drag and Drop system. GameMaker: Studio can be used to make games for a wide variety of platforms, including Windows, Mac OS X, Ubuntu Linux, Android, iOS, Windows Phone, and Xbox One.

GameMaker: Studio and the complementary GameMaker: Player is available at the YoYo Games company website, <http://www.yoyogames.com/gamemaker>. The Professional version of GameMaker: Studio can be purchased at https://www.yoyogames.com/get/studio_pro.

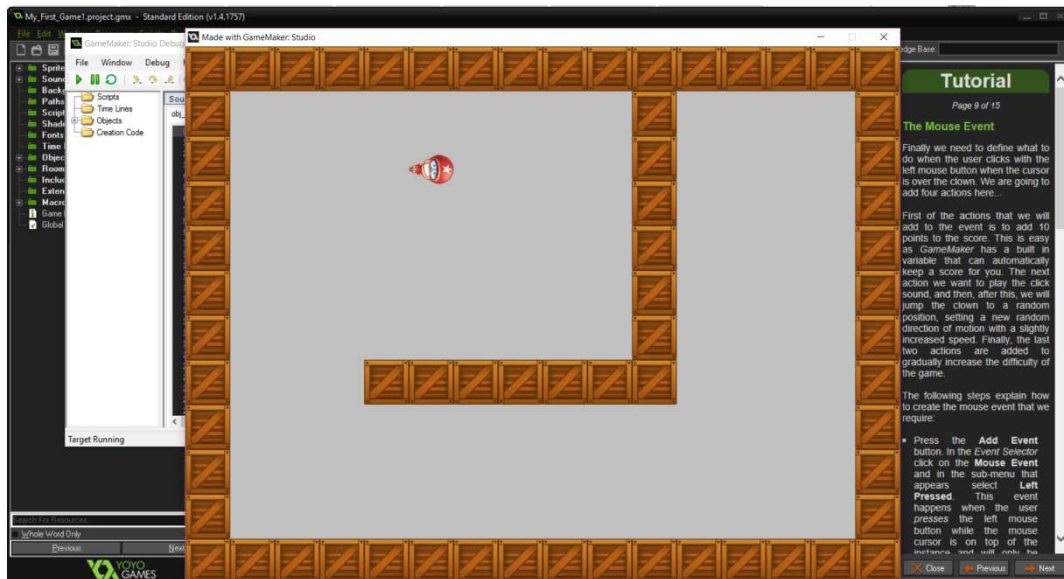


Figure 4. Running a simple 2D game made using GameMaker: Studio in the debug mode

Unreal Engine 4

Unreal Engine 4 is a 3D game engine manufactured and sold by Epic Games, a U.S. game development company headquartered in the city of Cary, North Carolina. The decision to make Unreal Engine 4 available for free to schools and universities, including personal copies for students enrolled in accredited programs, was announced by Epic on September 4, 2014. As of March 2, 2015, Unreal Engine 4 is free for everyone, and all future updates will be free as well. Unreal Engine 4.11 was released on March 31, 2016. Importantly for us, this version provides multiple new features for virtual reality (VR)

rendering. Figure 5 displays a screenshot of the installer package for Unreal Engine 4. The required storage space on a Windows PC is ~17 GB.

This tool can provide the 3D game and VR development functionality if substituted for Unity 5 in our CNIT 399 Introduction to Game Development course. In March 2014, Epic announced the switch from their proprietary UnrealScript to support for game scripting in C++. Numerous C++ project templates are available, provided that Microsoft Visual Studio 2015 is installed. Access to full C++ source code for UE4 is included. Also provided are sample projects, such as the Advanced Vehicle one shown in Figure 6. This way, the student does not have to necessarily start from a blank 3D space. While we prefer C# scripting of Unity 5, given that C# is the first programming language of our undergraduates, the schools that get their students started with C++ may favor Unreal 4.

Unreal Engine 4 can be acquired for free at <https://www.unrealengine.com/>. Commercial game developers have to pay a 5% royalty fee on gross product revenue after the first \$3,000 per game per calendar quarter.

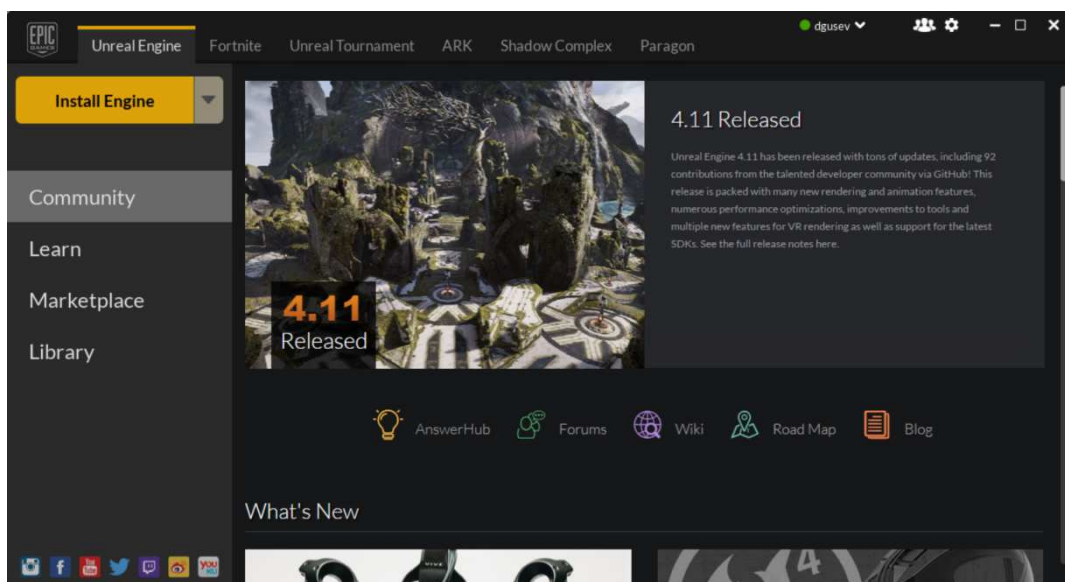


Figure 5. The installer package for Unreal Engine 4 in action

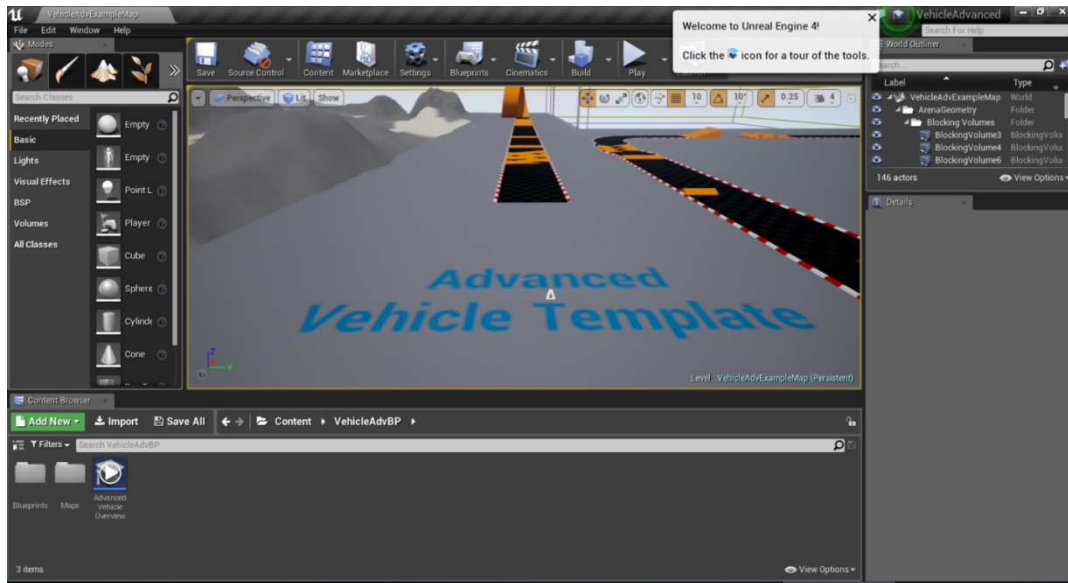


Figure 6.- The Advanced Vehicle sample project opened in the Unreal Engine 4 project editor

Microsoft Visual Studio 2015 Community Edition

The previously available free Express edition of Microsoft Visual Studio did not even have the tools needed to create 64-bit executables included by default, so an additional Windows Software Development Kit (SDK) had to be installed and configured with the IDE in order to enable that functionality. As a result of these and other limitations of the Express edition, we're currently using Microsoft Visual Studio 2013 Professional edition licensed by Purdue University to teach our programming courses — CNIT 155 Introduction to Software Development Concepts, CNIT 175 Visual Programming, and CNIT 255 Object-Oriented Programming Introduction.

However, the free *Microsoft Visual Studio 2015 Community* edition released July 20, 2015 contains so much more than the old Express! Included are the tools for cross-platform development, third-party (Xamarin) tools for C# development for Android and Windows phones, instruments for Profile Guided Optimization (PGO), 64-bit compilers, tools for Web development and advanced debugging, Visual Studio Tools for Unity, SQL Server Data Tools, etc. Multi-language support based on the .NET platform covers C#, Visual Basic, F#, C++, JavaScript, TypeScript, and Python. A screenshot of Microsoft Visual Studio 2015 Community is shown in Figure 7. Microsoft Visual Studio 2015 Community can be obtained for free at <https://www.visualstudio.com/products/visual-studio-community-vs>.

The reader may have already noticed the absence of Java, an immensely popular general-purpose programming language, from the options listed above. In another section of this paper we discuss a new free tool for Java development for Android, Android Studio.

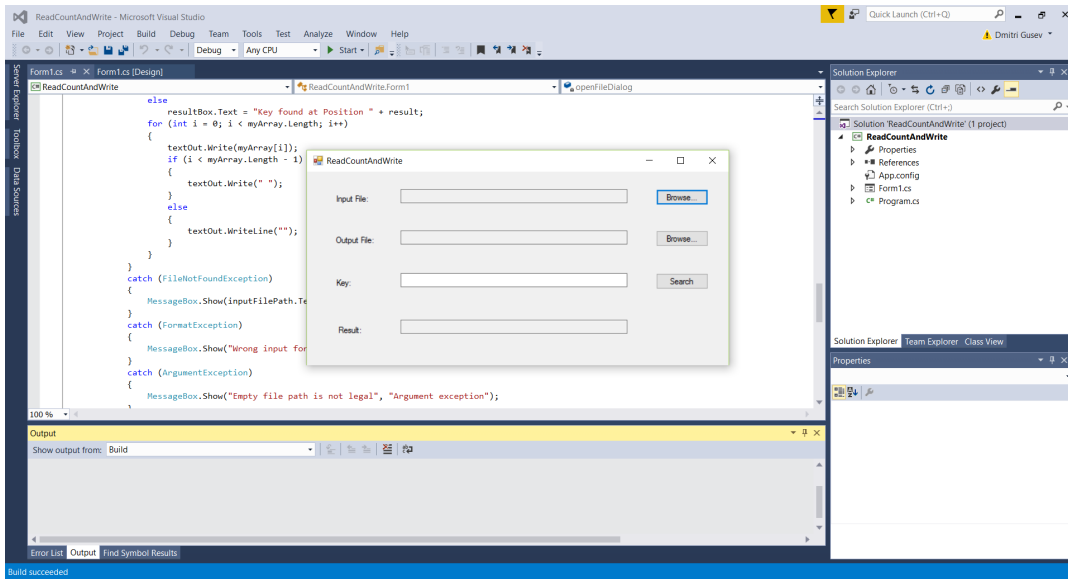


Figure 7 - A simple C# program is running in Microsoft Visual Studio 2015 Community

Android Studio

In our CNIT 355 Software Development for Mobile Computers course offered in the Fall of 2015, we replaced the Android Development Tools (ADT) bundle that included Eclipse, a well-known free IDE, with the new and similarly free *Android Studio* for app development, based on IntelliJ IDEA. A screenshot of Android Studio is shown in Figure 8. The window of an Android emulator running a ToDoList app with SQLite database support is seen atop the Android Studio IDE window.

Android Studio was developed by Google. Its first stable build was released in December 2014. Android Studio officially replaced ADT as Google's primary IDE for native Android application development. We used it to teach programming for smart phones or tablets running Android 4.1+.

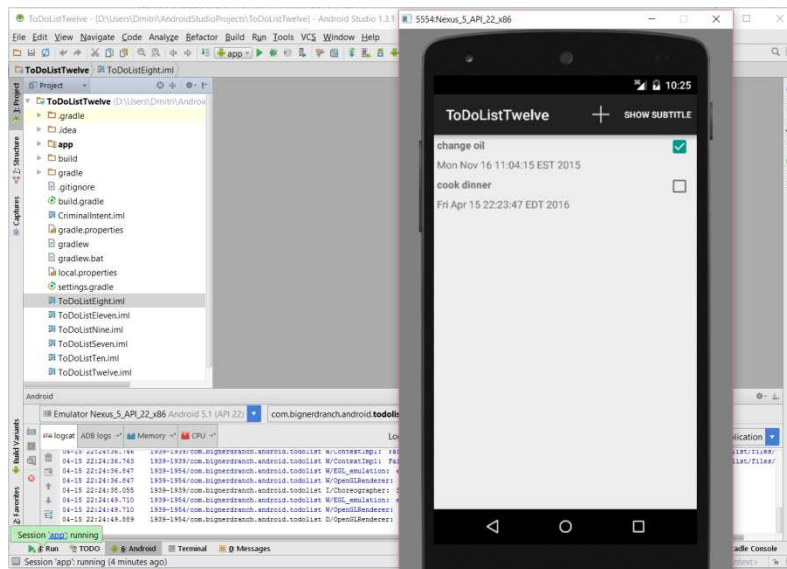


Figure 8. Android Studio with a running Android simulator

Conclusion

In this paper we have reviewed seven different products that we are either incorporating into our computer labs or are considering using in our labs. All of these are free. These products are replacing products that would in some cases replace very expensive products. Although the features may not be exactly the same as the software we are replacing, they all have the functionality required for our CIT classes and in some cases are superior to previous products.

References

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Oracle SQL Developer and Data Modeler, www.oracle.com

Unreal Engine 4, <https://www.unrealengine.com>

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