Tools to Use in an Information Technology Class – and Best of All They are FREE, Version 2.0!

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Abstract

We developed a paper for the 2016 ASCUE Conference with the topic of software tools to use in the classroom. As mentioned in the original paper, our Computer and Information Technology Department (CIT) curriculum at Purdue University statewide locations includes classes in database, networking, programming and systems areas. Most of these classes have labs using software that our graduates may use when they enter the workforce. The cost of purchasing software for the university labs and for students to use on their laptops can get very high. With a limited budget, it can be difficult to install all of the tools in the labs and expect students to purchase software they may only use one semester.

In our original paper, we covered tools, such as SQL Developer, Oracle Data Modeler, GameMaker, Microsoft Visual Studio Community Edition, and Unreal 4. Since the original paper came out, some licensing policies have changed, newer versions have become available, and we have found software that is a better fit for our classes. Besides giving an update on the original tools, we will discuss new tools that we have added to our toolset in the computer labs. In addition to the software utilized in the labs, we will expand our discussion to software that is not necessarily used in the labs, but can be used by our students on their own machines for our classes. Once again, best of all they are all free!

Presenters' Bios:

Dewey Swanson is an Associate Professor in the Computer and Information Technology Department at Purdue University's Columbus Indiana location. He teaches classes in the area of Database technology and Systems Analysis at Purdue. He has regularly attended the ASCUE conference since 1996.

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Introduction

Computer and Information Technology Department (CIT) is part of Purdue University's Purdue Polytechnic. The Polytechnic offers Purdue University degrees around the state of Indiana in their Polytechnic Statewide

program. The CIT program is offered in three statewide locations — Anderson, Columbus, and Kokomo, Indiana — besides the main campus in West Lafayette, Indiana. At the Columbus site we offer the Computer and Information Technology degree. This is the general degree program and classes offered focus on application development, systems analysis, database and networking. At the 3 sites offering our program, we have a total of 6 labs with hardware and software installed to support our program. Overall, in our Statewide system there are approximately 30 labs supporting the different degrees offered throughout the state of Indiana. There is not a set budget for hardware and software for the labs, but in recent years Statewide has spent approximately $125,000 a year to support the labs, with that number lower since the Covid pandemic. That is an average of just over $4,100 per lab. The Statewide budget, which is separate from the main campus in West Lafayette, has been flat for the last several years. With this flat budget, it can be difficult to get the software/hardware needed in the labs. Our CIT students may take up to 15 courses that contain a lab component. There is overlap in the software used in these classes, however the licenses for lab machines can be very pricey. As mentioned in our last paper, we are always looking for viable options to add software to our labs that come at either low cost, or no cost. In this paper, we will take a look at the software we used in 2015-2016 and discussed in our original paper. Some of the software is still used and has been updated, while other software is no longer being used and has been replaced by other options. Finally, we have a new section that will discuss free software that we have our students use, but it is not installed in our labs. The best news is, all of the options we will discuss in this paper are free.

UPDATE ON TOOLS WE USED PREVIOUSLY

In this section, we will take a look at the software we discussed in our previous paper. Are we still using the software, and has the software been updated or replaced? We will answer those questions. For complete details on each of these tools, see our original paper, ***Tools to use in an information technology class – and best of all they are FREE!*** from the 2016 ASCUE conference.

VirtualBox

VirtualBox is a category of virtual machine software or VM that can provide the user with an emulation of a particular computer that the user can manage and use. We have been using VirtualBox since 2013. This product can be a complete substitute of a real machine, in which the user can install operating systems and other software of choice. VirtualBox is free, open-source and owned by Oracle Corporation with its official name *Oracle VM VirtualBox*. VirtualBox runs on Windows, Linux, Macintosh, and Solaris hosts and supports a large number of guest operating systems.

VirtualBox has been used differently than our other software tools. We used the software for an asynchronous online class, and the software was not loaded in the labs. Instead, students load the software on their computers. 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 the product. Another advantage is that Oracle provides pre-built virtual machines that the student simply loads and is ready to go. The disadvantages for Virtualbox are that it can require a powerful machine to support some of the virtual machine appliances and the lack of support for the students, unlike the software installed in our labs.

We continue to use VirtualBox in CNIT 48700 Database Administration. This is an upper-level CIT class used as an introduction for students in the role of Database Administrator (DBA) using an Oracle database. As mentioned, we offer the CNIT 48700 as an online course to all of our locations. Students download the software from the website and are provided the appliance to use in the class. In 2016, we were running version 5.0 of the software with the latest version of VirtualBox, which is 6.1, as shown in **Figure 1**. With the update in software,

there are no major changes in ease of use and functionality. In addition to the newer version of the software, we now have VirtualBox installed in at least one lab at our three CIT locations.

One difference for students is, we now have VirtualBox installed in labs at all of our locations, in case students prefer to run VirtualBox on university machines or they are having issues with their machines. Also, since we originally started using VirtualBox, Oracle has provided additional pre-built appliances including Oracle WebCenter Portal VM, Oracle Big Data Lite VM and Database App Development VM. All of these come completely configured with the latest versions of Oracle and tools such as NoSQL and XML databases, along with their Big Data toolset.

VirtualBox is free and documentation and downloads can be accessed at : https://www.virtualbox.org/ . Oracle pre-built appliances can be accessed at: https://www.oracle.com/downloads/developer-vm/community-downloads.html.

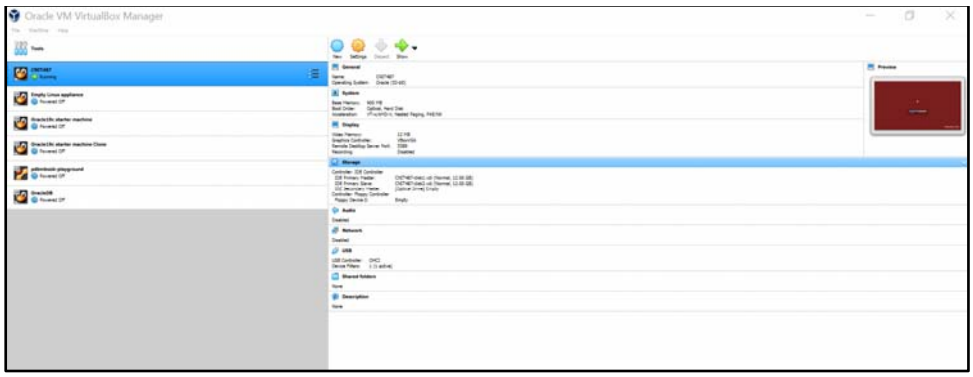

Figure 1. VirtualBox Version 6.1

Oracle SQL Developer

Oracle SQL Developer is an Integrated Development Environment (IDE) that provides programmers and administrators with tools to automate many of the development functions. SQL Developer is used on versions 10g and later and can run on any operating system that runs Java. SQL Developer is free and replaces SQL*Plus, a command line interface and other third-party tools that require a license or subscription to use on lab machines. SQL Developer provides an editor that can be used with SQL and PL/SQL to create code to execute queries, execute, test and debug code. Oracle SQL Developer will run on Windows, Mac OS and Linux platforms.

SQL Developer has several advantages over previous tools, such as SQL*Plus that was strictly a command line editor. It has a rich toolset that allows for program development and database administration. SQL Developer requires no installation and is simply an .exe file that is run. Students can also download and use the same software on their own device. The only real disadvantage is that it must be used with an Oracle database, which is not a problem, since all of the classes other than our introductory class use Oracle database. Note also that SQL Developer does not come with a database. You must connect to an existing database. Oracle does have a free database, Oracle Express, that is a free download. SQL Developer is installed in our labs in Anderson, Columbus and Kokomo. All students download and utilize SQL Developer on their own machines as well. We use Oracle SQL Developer in three classes — CNIT 272 Database Fundamentals, CNIT 372 Database Programming, and CNIT 392 Enterprise Data Management. The latest version of Ora-

cle SQL Developer is version 21.4.3, **Figure 2** features a screenshot of running version 21.2.1. In 2016 we were running version 4.1.4 and, with the update in software, there are no major changes in ease of use and functionality of SQL Developer.

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

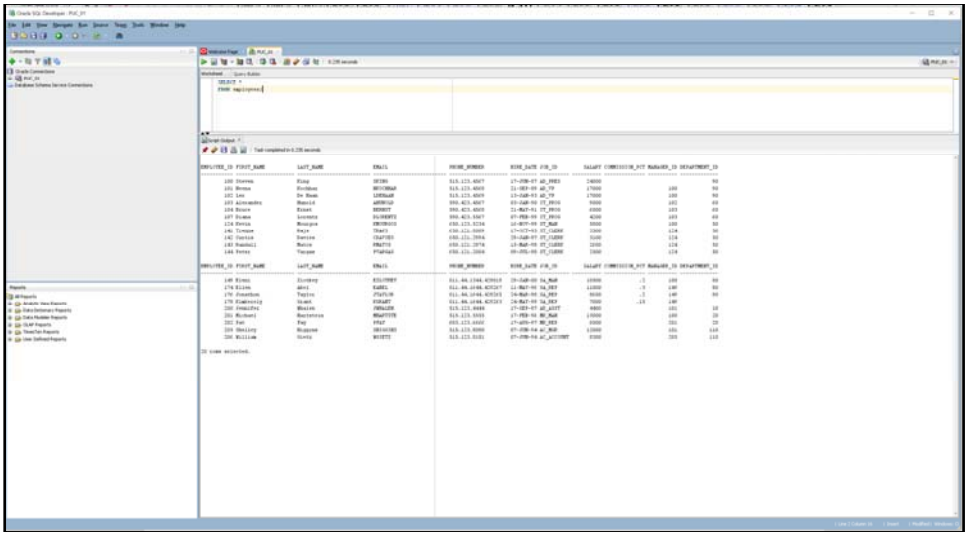

Figure 2. SQL Developer Version 21.2.1 with SQL code

Oracle SQL Developer Data Modeler

SQL Developer Data Modeler is a standalone product graphical tool that can be used to create and maintain logical, relational 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 was used to replace two tools — Oracle Designer and Microsoft Visio. An advantage of Data Modeler like SQL Developer is that it requires no installation, because it is an .exe file that only requires an operating system that can use Java. This makes it easy not only for lab machines, but also for students to access the tool at home. We still have Visio in our computer labs to support systems classes that model heavily using UML diagrams that are not supported by Data Modeler. The biggest disadvantage for Data Modeler would be that it does not support a wide variety of models.

Oracle SQL Developer Data Modeler is installed in all of the labs in Anderson, Columbus and Kokomo. All students download and utilize SQL Developer Data Modeler on their own machines as well. Unlike SQL Developer, you do not need a connection to a database to use it. We use Oracle SQL Developer Data Modeler in three classes — CNIT 272 Database Fundamentals, CNIT 372 Database Programming, and CNIT 392 Enterprise Data Management. The latest version of Oracle SQL Developer Data Modeler is version 21.4.2, **Figure 3** is running 19.2.0. In 2016 we were running version 3.1.4 and, with the update in software, there are no major changes in ease of use and functionality of SQL Developer Data Modeler.

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

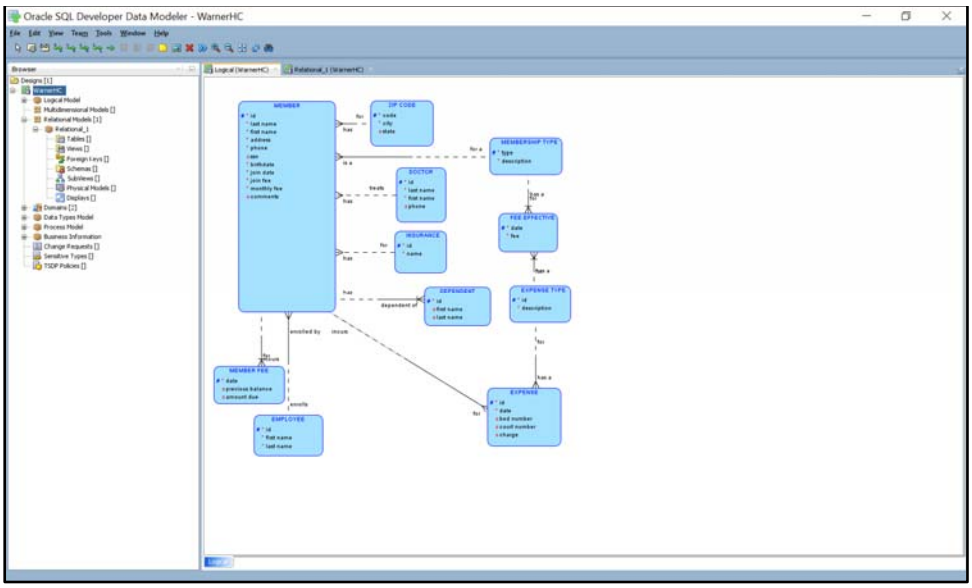

Figure 3. SQL Developer Data Modeler Version 19.2.0 with a logical model

GameMaker

GameMaker (formerly *GameMaker: Studio*) is a series of 2D game engines developed by YoYo Games and currently available at https://gamemaker.io/en. We considered it for adoption in our pilot course, CNIT 381 Introduction to Game Development Technology, that ran in Spring 2021. However, the decision was made to concentrate on 3D game development with Unreal Engine 4, which will be discussed next. The up-to-date pricing options for different GameMaker configurations, including the free one, are shown in Figure 4. GameMaker Educational licenses are available, per https://gamemaker.io/en/education.

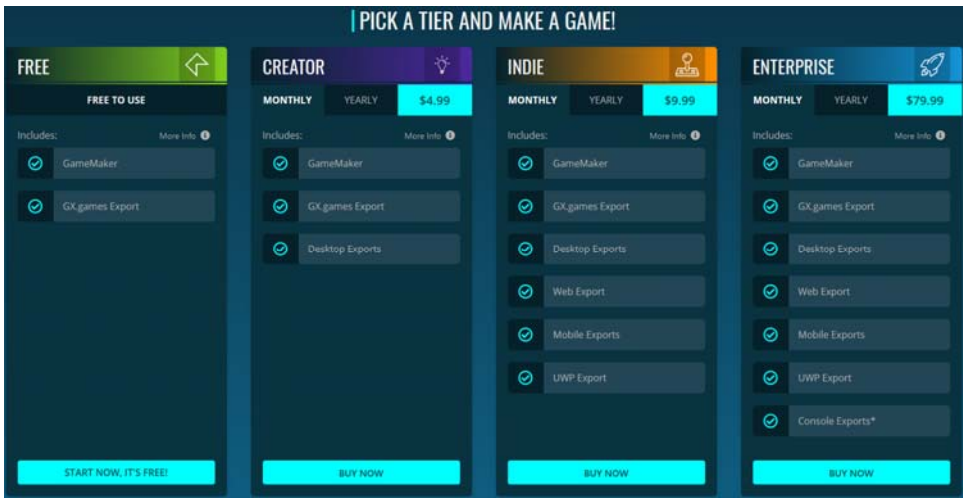

Figure 4. Pricing Options for GameMaker subscription products

Unreal Engine (UE)

For our Spring 2021 offering of CNIT 381 Introduction to Game Development Technology, our pilot course that succeeded CNIT 399 Introduction to Game Development, we switched from Unity, a popular game engine available at https://unity.com/, to its formidable competitor, *Unreal Engine (UE)* that we had discussed as an option in our ASCUE 2016 paper. Unreal Engine by Epic Games is known as the foundation of Fortnite, a popular online video game released in 2017. UE's newest Version 5 released on April 5, 2022, is available at https://www.unrealengine.com/en-US. Unreal Engine is free to use in many cases for game development — a 5% royalty only kicks in if and when your title earns over $1,000,000. In Spring 2021, our students used Unreal Engine 4.26.2. Figure 5 shows a screenshot of Runaway Robot, a puzzle game that a team of 5 students developed as their team project that semester.

Figure 5. Runaway Robot, a video game developed by our students using Unreal Engine 4

Figure 6 shows a screenshot of the control panel of the Epic Games Launcher, a tool that complements Unreal Engine by helping update and start it.

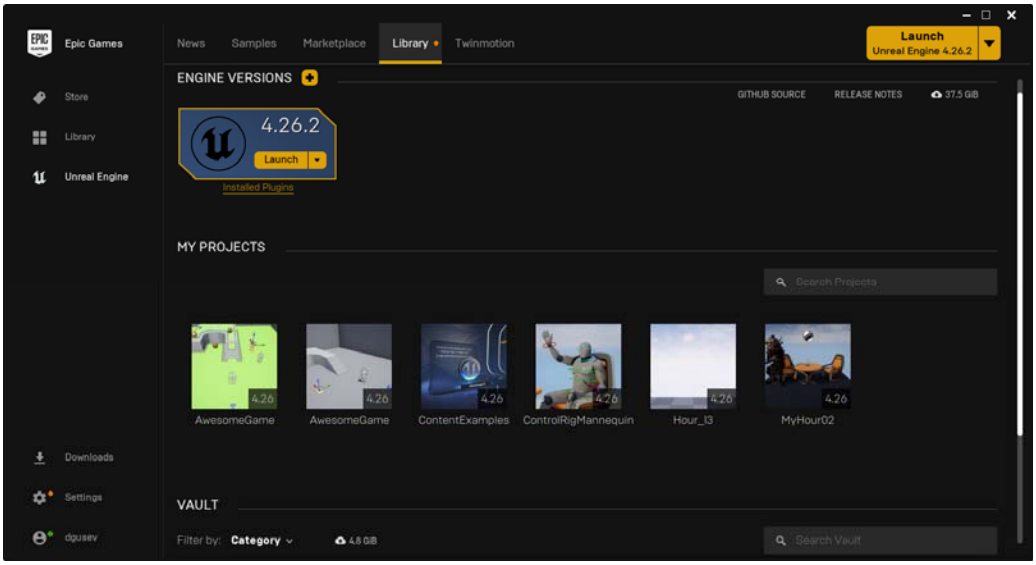

Figure 6. Epic Games Launcher, a tool that complements Unreal Engine (UE)

In the future, we intend to use Unreal Engine in the newly introduced CNIT 306 Game Development I: Core Skills and Technologies and/or CNIT 308 Game Development II: Design and Psychology.

Microsoft Visual Studio Community Edition

In our ASCUE 2016 paper, we discussed the rationale for using Microsoft Visual Studio 2015 Community Edition in three of our courses — CNIT 155 Introduction to Software Development Concepts, CNIT 175 Visual Programming, and CNIT 255 Object-Oriented Programming Introduction. Our latest offerings of these courses (Fall 2021 and Spring 2022) involved using Microsoft Visual Studio 2019 Community Edition. The latest version currently available at https://visualstudio.microsoft.com/vs/ is *Visual Studio 2022*. Figure 7 shows a screenshot of feature comparison of the product's three editions (Community, Professional, and Enterprise) captured at the manufacturer's web page https://visualstudio.microsoft.com/vs/compare/.

Supported Features	Visual Studio Community Free download	Visual Studio Professional Buy	Visual Studio Enterprise Buy
Supported Usage Scenarios	●●●○	●●●●	●●●●
Development Platform Support	●●●●	●●●●	●●●●
Integrated Development Environment	●●●○	●●●○	●●●●
Advanced Debugging and Diagnostics	●●○○	●●○○	●●●●
Testing Tools	●○○○	●○○○	●●●●
Cross-platform Development	●●○○	●●○○	●●●●
Collaboration Tools and Features	●●●●	●●●●	●●●●

Figure 7. Epic Games Launcher, a tool that complements Unreal Engine (UE)

As you can see, the Community Edition remains free, while providing the essential development platform support under the auspices of a production-strength Integrated Development Environment (IDE).

Android Studio

In the Fall 2021 and Spring 2022 semesters, we continued to use Google's *Android Studio*, a free IDE for Android application development based on IntelliJ IDEA. Android Studio is available at https://developer.android.com/studio. In the latest offerings of the corresponding courses — CNIT 355 Software Development for Mobile Computers and CNIT 425 Software Development for Mobile Devices II — we have switched from Java to Kotlin, a closely related language that has become Google's recommended choice for Android development and reportedly crossed the 50% mark in developer preferences a couple of years ago. The courses taught Kotlin programming for smartphones or tablets running Android 6+. Figure 8 features screenshots from Dante, an arcade-style mobile game built by a team of students in CNIT 355. Figure 9 shows the PhotoGallery app (CNIT 425) running in an emulator.

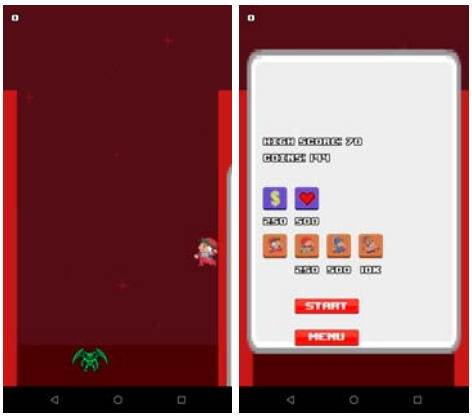

Figure 8. Screenshots of Dante, a mobile game built by students using Android Studio

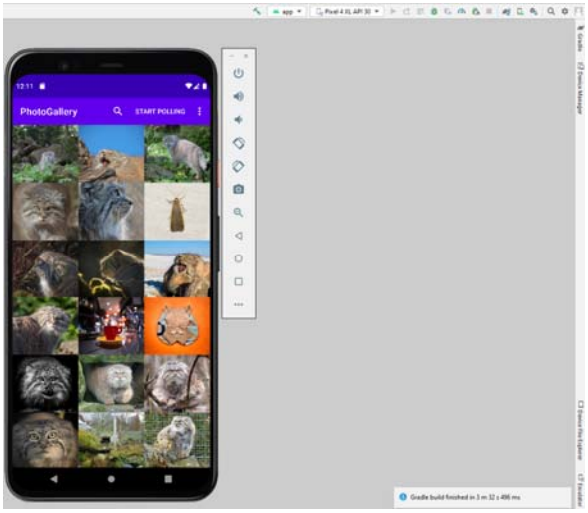

Figure 9. PhotoGallery app submission running in an Android Studio's device emulator

NEW FREE SOFTWARE IN THE LABS

In this section we will review some options that we have incorporated or plan to incorporate into our labs since our previous paper in 2016. Again 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.

Tableau

Tableau is a software tool used to analyze and provide data visualization from a variety of inputs including many of the popular relational databases and spreadsheets. As they market themselves on their website Tableau is "the market-leading choice for modern business intelligence, our analytics platform makes it easier for people to explore and manage data, and faster to discover and share insights that can change businesses and the world". Beginning next year our CIT department will offer a new major, Data Analytics, Technologies, and Applications (DATA) major. As the name implies the major focuses on training students in the area of data analytics. Over the last three years we have been developing the program. This has involved revising several existing core classes and the development of new classes to add to the curriculum. One of the classes that is part of CIT core is CNIT 272 Database Fundamentals that is common across all CIT majors. This class has focused on designing databases and programming using SQL with relational databases. With the new DATA major we have added a new section to the class focusing on an introduction of data visualization. We were not able to use existing software we had installed on our labs. After investigating several tools from basic spreadsheet to Microsoft's Power BI and Tableau we decided on Tableau. Tableau offers a huge selection of interactive charts that can be used for data presentation. It is ranked as one of the leading tools on the market today. As with all of the tools Tableau is free to accredited, degree-granting, academic institutions. Currently, Tableau offers an Instructor License, Student Bulk License and Lab Bulk License which we have at our Statewide location in Columbus. A plus of using Tableau is that they have instructional material free for instructors and allow faculty to sit in on Tableau classes when there are open seats in a some of their courses. The only issue we have had so far is due to the lab we are using it in. The lab is a shared lab among 3 institutions using virtualized machines and occasionally we have had issues utilizing it in the lab. Students are also able to use the Public version of Tableau on their own machines. As we offer additional classes in the DATA major, we anticipate additional classes to use the Tableau software.

Tableau is a free product for use in educational settings and can be accessed at https://www.tableau.com.

Code::Blocks

We used *Code::Blocks* to teach the fundamentals of C programming (CNIT 105 Introduction to C Programming, Spring 2017) and advanced C++ programming (CNIT 315 Systems Programming, Spring 2021). Code::Blocks is a free C/C++ and Fortran IDE available at https://www.codeblocks.org/. Importantly for the latter course that involved a great deal of parallel/concurrency programming (an essential component of modern systems programming), the latest Code::Blocks release 20.03 (Mar. 29, 2020) supports makefiles and the C++17 programming standard.

FREE TOOLS TO USE IN CLASS BUT NOT IN LABS

Visual Paradigm

In many of our systems courses students need to use modeling tools. Oracle Data Modeler will handle entity relationship diagrams but would not support many of the Unified Modeling Language (UML) diagrams that are

incorporated into the systems curriculum. We have had a license to use Microsoft Visio Professional edition that supports those needs for many years. The problem we had until recently is that students were not able to access that on their own machines. The cost of the latest version for a one-time purchase is $579 licensed to 1 machine. So that students would not have that expense for 3 classes in their plan of study we allowed students to use Visual Paradigm for their modeling. The advantage to Visual Paradigm is that it is free and supports all of the diagrams we use in our systems classes such as Data Flow Diagrams, Use Case Diagrams, Class Diagrams, Activity diagrams and many more. The downside is that we were not able to install the free version in our labs. The latest version of Visual Paradigm is version 16.4 shown in Figure 11. Within the last several years Purdue University has entered into an agreement with Microsoft to allow students to access Microsoft Visio Professional Edition, however after the first class in the systems curriculum, CNIT 180 Introduction to Systems Development we are not tool specific in our systems courses so student can use whatever tool they prefer.

Visual Paradigm Community Edition is a free product and can be accessed at:
https://www.visual-paradigm.com/download/community.jsp

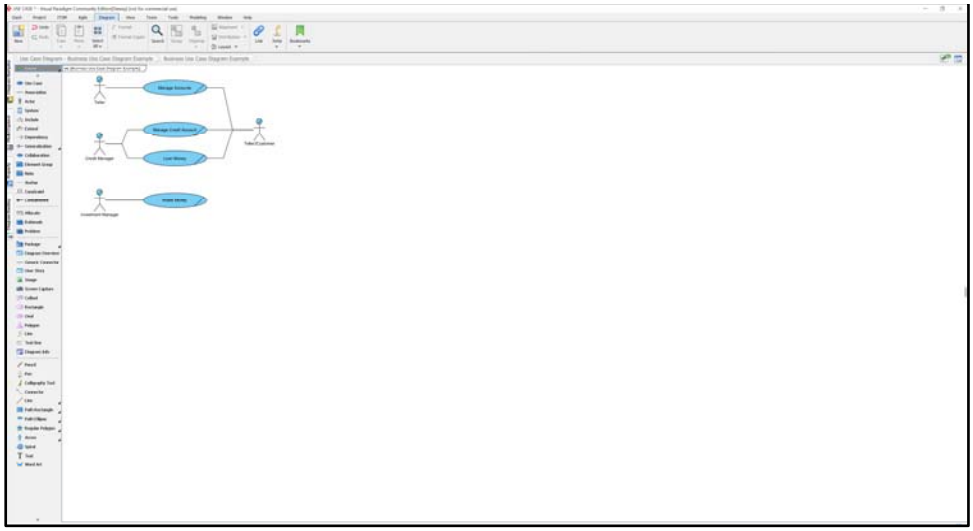

Figure 10. Visual Paradigm Version 16.4 with a Use Case Diagram

Oracle Academy and Cloud products

Our Columbus campus has been a member of Oracle Academy for over twenty years. They have provided free software, curriculum, discounts for instructors to attend Oracle University classes, and discounts for students to take Oracle certification exams. The membership is free for higher education but also K-12 schools. In the last several years, Oracle appears to have put more resources into the program with many new free resources. As a member the Oracle software is available for free to use in our labs.

With the Oracle Academy we have the latest version of the Oracle database software available in our labs and at home for the students. This is free for the university as long as it is used in an educational environment and not used for commercial purposes. Our IT support install and configure the databases for student use. Students are allowed to download and use the same software as long as they download and sign a Student User Agreement. This is the method we support our database needs in CNIT 272 Database Fundamentals, CNIT 372 Database Programming and CNIT 392 Enterprise Data Management.

Another option Oracle Academy provides is to host the database for a course. The big advantage is this eliminates the university from having to install and maintain the database on university resources. Our Columbus campus as mentioned installs the Oracle database on our own servers, however our main campus in West Lafayette just recently utilized this in the CNIT 272 Database Fundamentals course. The disadvantage is that the user has a standard configuration and you have to go through Oracle to make any modifications.

Finally, in the past couple years Oracle Academy has developed the Oracle Academy Cloud Program, which provides universities free access to Oracle and open-source technologies. The instructor at the university requests a Cloud account, requests Cloud resources and then requests Cloud resources for the students. From the Oracle Academy website you can :

Teach and learn Oracle Autonomous Database in Oracle Cloud
Access Compute VM, Oracle APEX, SQL Developer, storage, and network resources
Work with Oracle, MySQL, NoSQL, big data, and open-source databases
Develop in Java, Node.js, Python, PHP, and Ruby

At this point we have not utilized the Oracle Academy Cloud Program in our courses but with our new DATA major that was mentioned previously there appears to be many useful resources in the program.

Oracle Academy is free and can be accessed at https://academy.oracle.com/en/oa-web-overview.html.

Conclusion

In this paper, we have updated our review of numerous software products that we are either incorporating into our computer labs, or have considered for use in our labs, or had our students install on their computers to support their coursework. All of these software products are free. These products are replacing products that would in some cases be very expensive for the University and/or students. Although the features may not be exactly the same as those of the software that was replaced, the reviewed products all have the functionality required to meet the learning outcomes of our CIT classes and in some cases are superior to previous products.

References

Android Studio https://developer.android.com/studio

Code::Blocks https://www.codeblocks.org/

GameMaker, https://gamemaker.io/en

Microsoft Visual Studio Community Edition, https://visualstudio.microsoft.com/vs/community/

Oracle Academy, https://academy.oracle.com/en/oa-web-overview.html

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

Tableau, https://www.tableau.com

Unreal Engine, https://www.unrealengine.com/en-US

VirtualBox, www.virtualbox.org

Visual Paradigm, https://www.visual-paradigm.com/download/community.jsp