Slot Machine Development: A Course for CS Majors

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ABSTRACT

As students prepare themselves for careers in gaming, an overlooked area of gaming is gaming for money, or casino based gaming. Students often graduate college with basic skills required for entry level positions in traditional video gaming areas, however basic skills for the casino industry are rarely taught. Students who wish to have a career in the gambling industry would benefit from additional industry specific training prior to leaving college. This paper outlines a pilot course taught for this specific purpose, as well as describes the hurdles faced when developing materials for a largely guarded industry and how they were overcome.

Categories and Subject Descriptors

L.3 [**Science and Technology of Learning**]: Information Retrieval and Search

General Terms

Information retrieval, gambling, slot machine

1. INTRODUCTION

Computer science and game design college students are often taught the skills needed to survive in the mobile games and home console based games industries. However, a specific area of gaming is left out of these courses. Casino gambling and slot machines generate revenues in the billions of dollars each year [1],[8] and that number is expected to grow [8]. Students may have the desire to jump into this growing industry, but may lack certain industry specific knowledge that gaming companies desire.

A few decades ago, legalized gambling in the United States was isolated to Nevada and New Jersey. Since then, gaming has been undergoing an expansion that started in the 1990's with the explosion of tribal gaming. States have also relaxed their gaming laws with all states except Utah and Hawaii having some sort of gambling legalized. Many states contain a state run lottery system and allow charities to hold bingo sessions. As state governments look for alternate sources of revenue, gaming expansion is usually mentioned in the discussion.

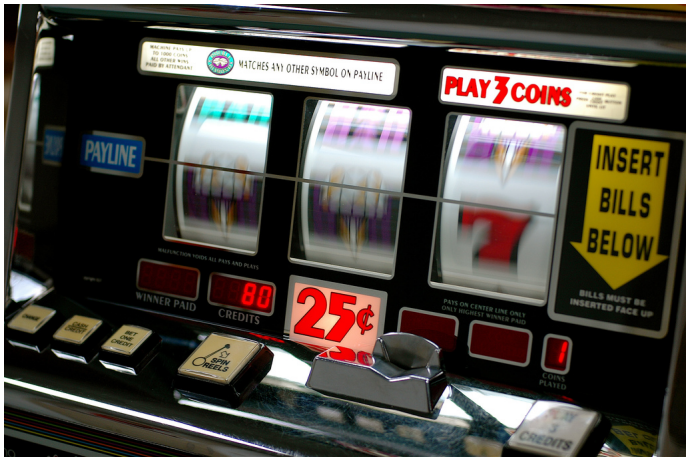

Figure 1: Simple 3 Reel 1 Line Slot Machine [9]

Gaming has traditionally been heavily regulated and limited only to physical casinos. Several grey market online gambling sites have been established and shut down since the internet's mass market appeal began in the mid 1990's. In 2012, Nevada became the first state in the United States to legalize internet based gambling [15]. Although limited to Poker, it was a big step in bringing the gaming industry up to the same level of acceptance and technology as other areas of entertainment.

Following Nevada's lead, New Jersey [17] and Delaware [14] allowed internet based gambling in 2013. The laws in these eastern states differed from Nevada in that all forms of accepted gambling could be performed via the internet including slot machines. It is anticipated that online gambling will continue to make its way through the legal approval process and very soon it may be available in more states.

Because of this expected expansion, it is important that game designers and developers of the future properly understand this industry and how it differs from traditional video games. A course was developed and tested at University of Nevada, Reno that instructed students on the basics of this industry. This paper discusses the contents of a com-

puter science course about gambling applications, provides an example of alternate ways to obtain course materials for proprietary industries, and lists out several student defined projects.

2. COURSE CONTENTS

The computer science course was designed as a 400/600 level course, which meant that students taking the course were either seniors or graduate students. The course was administrated by a gaming industry expert who had over 13 years experience in leading software development teams in the gaming industry as well as a PhD in Computer Science. There was no reference for teaching a course such as this, so the course syllabus and all materials were produced by the visiting professor.

In general, the course consisted of lectures on gaming topics, labs relating to the technology described in the lectures, written tests, current events, and student projects. At the conclusion of the class, students presented their final projects to invited members of the gaming industry as a demonstration of their industry skills and knowledge. The desired learning outcomes of the course include a basic history of the gambling industry, real world application of probability and statistics, ability to read and understand patents and protocol documents, and implementation of slot machine features.

The course began with an introduction to gaming. Students were shown the evolution of slot machines, from mechanical slots that awarded gum to licensed titles that pay out millions. The fact that the basics of the slot machine have not changed in over 100 years was emphasized in order to have the students think in the mindset of what attracts players to slot machines.

The first two weeks of the course consisted of describing the different features of slot machines. Specific gaming terms were identified. Students were exposed to reels, symbols, paylines, denominations, bets, and paytables. Features of slot games were demonstrated such as bonus rounds and progressives. And to wrap up this section of the course, students were shown a variety of hardware models. In casino gambling, the manufacturer provides the software *and* the hardware which draws a parallel to first party development in the console industry. In casino gaming there is very little third party development.

The course then dove in to an overview of devices. Students were shown that slot machines are doing a lot of work even when no one is playing them. Slots need to communicate with many different devices including bill validators, ticket printers, progressive signs, touch screens, physical button input, door switches, magnetic card readers, coin acceptors, as well as physical reels (Fig. 2).

In addition to communicating with devices contained within the slot machine, slots also have to communicate with external hosts. These include accounting systems, event monitoring systems, player loyalty systems, bonusing systems, and progressive systems. The basics of protocol communications were shown and students were asked to think about all of the different pieces of information slot machines need

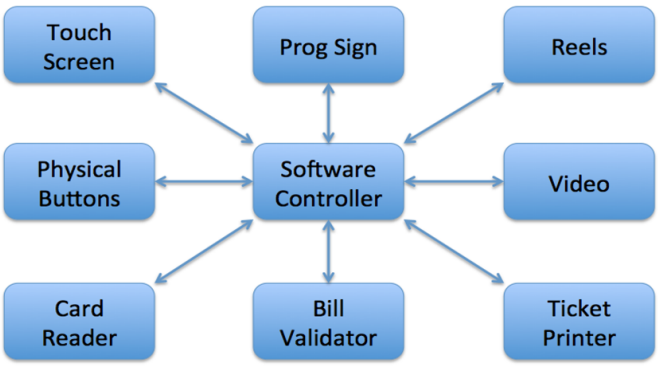

Figure 2: Slot Machine Devices

to communicate to the different hosts. For example, if a casino is using a cashless based credit transfer, what types of information does the slot machine need to send to the central ticket host system when printing a ticket? Students sketched out their own version of a protocol and as a class the various solutions were discussed.

As the success or failure of a slot machine depends on how much money the machine profits, a substantial amount of time was spent on the math behind slot machines. As an introduction to the topic, students were exposed to terms specific to the gaming industry in broad descriptions, subsequent class sessions were spent going over the details of important concepts. Slot terms discussed included payback percentage, hold percentage, hit frequency, and volatility index.

As there was no math prerequisite for this course. Prior to digging in to the details of the math terms, one week was spent on a basic introduction to statistics. Students were shown the probabilities and statistics surrounding coin flips. And then moved to applying the same concepts to a bag of different colored marbles, and finally on to three bags of different colored marbles. Students were shown that the math driving a three reel slot machine (Fig. 1) is no different than the math behind three bags each containing a mix of different colored marbles. In the slot machine world the bags are represented as reels and the different colored marbles are represented as different symbols. This basic analogy helped students gradually grasp the apparent overwhelming nature of the math behind slot machines.

These math principles were then applied directly to slot machine scenarios such as reel strips and virtual reel strips. Students defined their own reel strips and calculated the change in payback by making small adjustments to the count and sequence of the symbols. Students were shown the standard 22 stop slot reel arrangement and this was used as the basis for slot based projects in the class. The idea of pseudo random numbers was introduced at this point in the class and students were shown what constitutes a good and a bad random number generator by the standard testing lab GLI [4]. The class was also exposed to a real world keno example where famous slot machine cheat Ronald Harris [16] latched on to the RNG sequence and was able to correctly predict the outcomes of keno games prior to them starting.

The concept of math was then expanded to include large progressive jackpots. These are typically large jackpots that increase every play. Students learned about a contribution percentage and how that effected the overall payback of slot machines. In addition to progressives, the math surrounding featured pick 'em bonus rounds and free spin games was analyzed and calculated for several basic games containing these features.

The course then taught students about state machines when in the context of slot machines. As slot machines are dealing with people's money, it is very important that states be well thought out and progress saved in non–volatile memory. In the event of a failure, regulations require slot machines restart in the exact same state just prior to the failure occurring. This is much different when compared to video games where the restored state may be several minutes or hours before the failure occurred.

In addition to restoring states in the event of a software or hardware failure, students learned about the need of enhanced game logging to identify bugs and solve player disputes. It was demonstrated how a last game recall can show a player what happened for many games in the past. This can resolve issues when the player thinks he saw a win, when in reality it was a loss. Casino personnel can go through the last several plays of the game with the player and show him how all the payouts were correct. In the event of a catastrophic failure, students were shown the need to log why the slot machine encountered an irrecoverable error.

Once the basic features of slot machines were identified, the course took the students through actual implementation of a paytable. Previously in the course, students were exposed the definitions of which symbol combinations paid out certain amounts of money, however now students actually implemented the paytable in code. Different strategies were discussed for code optimizations. Students implemented pay structures, reel strip containers, wild symbols and scatter symbols.

Graphic drawing routines were analyzed and discussed. Students learned how to correctly simulate physical reels in a 2D video environment. Frame rates and the amount of pixels to move on each frame update for each symbol were discussed and shown. Students learned that when drawing a video slot machine containing three visible symbols when the reels are in their stopped position requires the drawing of four symbols when they are spinning.

Although by numbers of video machines on a casino's floor slot machines are at the top, most casinos also have many video poker machines. Students learned about video poker, its payouts, and optimal hold strategies. Students learned about the different types of video poker machines including: Five Card Stud, Jacks Or Better, and Texas Hold 'Em. Different jurisdictions allow different types of poker to be played and these requirements were discussed within the class.

In order to promote the writing of defensive software, a section of the class was dedicated to analyzing past slot machine cheats and exploits. Students were given the assignment to think about ways to prevent these cheats from occurring via software or hardware solutions. Also students were to research regulatory documents to show how the industry protected itself against the cheats.

Another topic important to gaming is Central Determination based games. These are games where the outcome of an individual game play is determined on a remote server as opposed to on the gaming device the player has control over. In this class, students were exposed to these types of networks, including slot machines based on high speed bingo, instant lotteries, and electronic pulltabs.

Describing methods for central determined games led into a discussion on jurisdictions. Gaming is challenging in that each country and each state has different rules as to what constitutes a legal gambling device. Students were exposed to differences in laws between New Jersey, Nevada, Mississippi, Class II. In addition to being made aware of all of the differences, students learned about strategies for dealing with them when writing software.

The course also looked at industry standard host based protocols such as SAS and G2S. Students learned what types of technologies these standards used (serial vs TCP/IP) as well as what types of features each protocol supported. The history of these protocols was also discussed and students were shown how the gaming industry evolved through all of the iterations of host based systems.

Finally the course wrapped up with a look at current and future trends in online gaming. A history of legal and illegal online gambling for real money was discussed. Students also became familiar with ongoing legislation at the state and federal level. In addition to studying online gambling for money, students were also exposed to freemium based online games where people spend real money to play slot machines in order to have a chance at winning virtual goods.

3. COURSE MATERIALS

Materials for the course were gathered and prepared by the instructor. A book on this subject did not exist and as a result materials were generated specifically for this course.

One issue in instructing a course such as this is the amount of proprietary information that is involved with building and using gaming technologies. This is a highly patented and highly confidential industry where even the most basic pieces of information are very guarded. When instructing a class on a topic that all gaming companies utilize, for example what a PAR sheet is, it is hard to describe this material without using an example. A PAR (paytable and reel) sheet in gaming is a written description of the math of the slot machine. Generating this information for the purposes of a class will only give students a rough idea of what is contained on a PAR sheet. Showing one will let students understand exactly what format it is in and how to read it. The following sections list out publicly available resources for the different topics covered in this course.

3.1 Regulatory Standards

As part of regulatory requirements some documents are publicly available. SAS (Slot Accounting System) is a proprietary gaming protocol created by IGT [11]. A license must

be obtained from IGT in order to receive the protocol specifications. In the case of this class, becoming a licensed developer was slightly overkill as the point of the class was not to go in depth into all the aspects of a gaming protocol, but it was to show how protocols work to give students experience in working with gaming protocols. The specifics of SAS were not an objective of this class.

It is generally required that state gaming standards are made publicly available. In the case of Montana [11], the state requires that gaming devices communicate with each other using the SAS protocol. The protocol specification as defined by the state of Montana was used to cover more details about the SAS protocol in class. Although the document available through the state of Montana's website was not a complete SAS 6.x compliant manual, it provided enough of a foundation to explain relevant topics.

The Montana SAS document specified the physical interface between the host and the gaming terminal. The interface is a 232 based serial protocol running at the 19.2 kbps. It also lays out that each terminal is given a unique address between 1 and 127 and that all terminals are polled by the host with each terminal being required to respond to a poll within 20 ms. These types of details are important for students to understand as they enter the industry.

In addition to physical communication characteristics, the Montana document contains information about specific messages between the host and the gaming terminal. The document clearly defines a general poll, and the required event exceptions that the game can send back. Exceptions listed in this document include events such as slot door opens, bill jams, bill accepted, exception buffer overflow, and game soft meter reset. These pieces of the protocol are not only important from the operator's standpoint, but also from the developer's standpoint as well. Knowing that these types of exceptions exist and are required will better prepare the students for the types of defensive code needed to have a successful career in the gaming industry.

Other parts of the SAS protocol covered by this document include definitions for sending slot machine meters, including cancelled credits, coin in, coin out, games played, games won, jackpot, current credit meter, accounting for each denomination of bills, and accounting for multigame slot machines.

These areas of the standard protocol are important to not only explain, but show how they are required such that students will understand everything that takes place in the background of a single slot machine play. To the every day person, video slot machines may seem simple, but the regulatory requirements make the behind the scenes programming challenging.

3.2 Patents

Patents are available for the public to analyze and as the gaming industry is heavily patented [18], these proved to be a great source of material as well as a great way to introduce students to real world examples.

Bonus rounds in slot machines are common game play me-

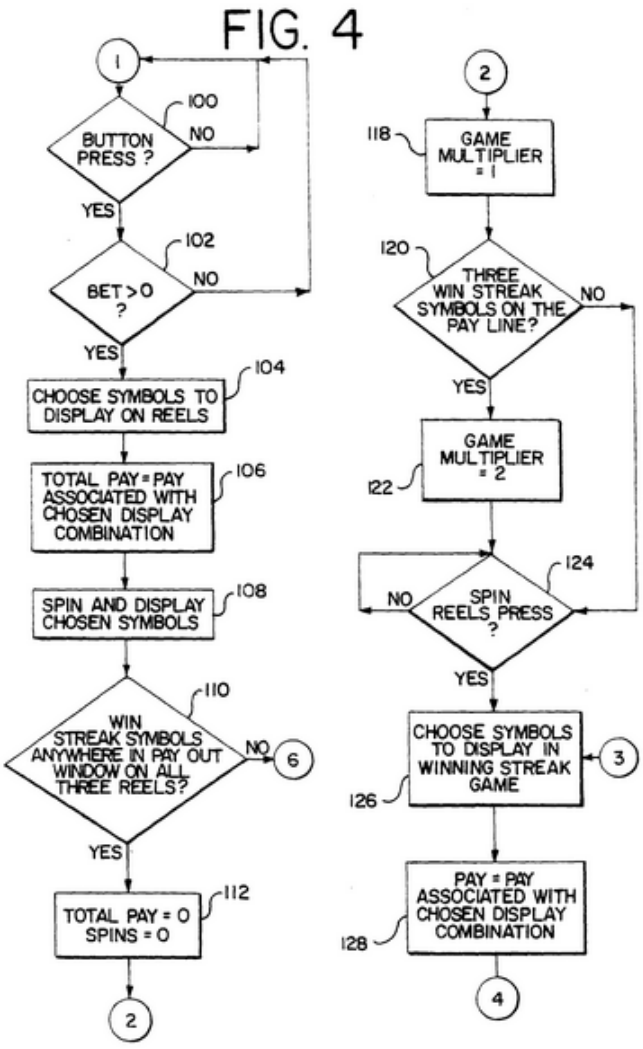

Figure 3: State Machine from Patent [2]

chanics. The methods of awarding the outcomes are heavily patented. The class analyzed an early patent [2] (Fig. 3) defining the initial game play of slot machine bonus rounds. This patent was general enough to provide a big picture of how bonus rounds function.

This early patent demonstrates a state machine diagram that shows how slot machine states work in general. It also shows a state machine for a specific win dealing with a bonus trigger. These types of state machines are extremely useful in the implementation of slot machine games. Another piece of this patent clearly shows the probability of different base game symbols and combinations which is another example of how slot machine math is structured. In addition to base game slot machine math, the patent also reveals the logic and payouts behind free spin games – that is games that play and potentially pay without charging the player for the spin. Finally, this patent includes a description for the math behind a spinning wheel bonus round, including pay amounts, probabilities, and pay contributions. More recent patents have been issued covering bonus games, but they cover very small nuances of bonus rounds.

A section of the class was related to central determined lottery based systems. A particular patent [10] was read and analyzed prior to discussing the topic. Reading this patent was assigned, and students came to class prepared with questions and discussion topics. This patent demonstrates how an electronic lottery can be used in a real time gambling operation as opposed to the twice a week Powerball style lottery that has become mainstream. This patent shows how players can obtain an instant lottery ticket and have the result shown like a typical slot machine style of a win. Students used the knowledge obtained by studying this patent in a lab environment where an instant lottery client slot machine was used to display the result of a remote electronic lottery draw.

In addition to describing lottery based systems, a patent [3] was used to demonstrate the math behind a game of bingo. Students read the patent which provided background information on the probability of different bingo patterns. Students could then assign different pay values to these patterns and see how the payouts were effected. The 11 patterns shown in the patent were based on a standard 5x5 bingo card. This patent also included a good example of a payout evaluation state machine, where patterns were first analyzed, then payouts were awarded based on predetermined probabilities. The legal environment at the time at which this patent was filed was also discussed. The timing of this patent was during the time the National Indian Gaming Commission was assigning classifications to existing bingo games and setting the standards for what constitutes an electronic bingo game.

3.3 Freedom of Information Act

In gaming the common term for documents defining the payouts and overall math of a slot machine is a PAR Sheet. The math behind slot machines is a closely guarded secret. Not only do slot manufacturers want to keep the specifics about their games hidden from the players, but they also want to keep the specifics hidden from their competition. Math and PAR sheets could be created specifically for this class, however that math would not be exact or in the exact format that the industry uses as the formats vary from company to company. Showing a variety of PAR sheet formats would benefit the students as they would have knowledge from several pieces of industry. As the class contained students from different gaming companies, obtaining PAR sheets directly from the manufacturer would be difficult and the students would be required to sign non–disclosure agreements, which may not have even been possible due to gaming industry standard non–compete agreements.

Fortunately data retrieved via the Freedom of Information and Protection of Privacy act in Canada allowed for several PAR sheets to be published [7]. The information published allowed students to see PAR sheets for 23 versions of two traditional mechanical reel slots and two video slot games.

The PAR sheets demonstrated to students in the class the amount of documentation that is required for just the math portion of the slot game. The math documents identified important characteristics such as minimum/maximum wager amounts, symbols per reel, symbols per virtual reel, payback percentage, hit frequency, plays per jackpot, jackpot amount based on credit bet, plays per bonus and the volatility index. The games whose PAR sheets were publicized include Double Diamond Deluxe, Lucky Larry's Lobstermania, Money Storm, and Phantom of the Opera – which were all slot machines that were common in most casinos.

PAR sheets also contain different information based on different payback percentages. For example, a slot machine that pays back 85.2% will have a different distribution of symbols than the same title that pays back 87.8%. All of the differences that make the payback different are required to be documented and showing all these differences to the students based on actual PAR sheets enforced the attention to detailed required to release a slot machine into a regulated jurisdiction.

The documentation required to describe the math also must show specifics about how the bonus rounds are played. In the case of Lobstermania, the player can win extra credits by choosing different floating buoys on the screen. Each buoy has an associated win amount, and that win amount is not completely random. It is chosen randomly through a weighted table. Students learned the industry standard for displaying this weighted table, which includes calculating an expected average pay each time a player enters the bonus round.

3.4 Open Source Software

Open source software provides an opportunity to distribute the work required to produce large scale projects. The gaming industry is currently undergoing a transformation in regards to how information is being passed from the gaming terminals to the host systems. The previous generation of slot machines and gaming devices provided information to the host systems commonly through the SAS protocol. This protocol was proprietary to IGT and permission needs to be received from the slot machine company in order to use it.

The next generation of gaming machine to host communications set out to be a more open format. This format was put

together by GSA (Gaming Standards Association), which is an international trade association for the gaming industry. Representatives of gaming companies make up the standards committees and determine the overall protocol requirements. Unfortunately this is not truly an open system, as in order to receive the protocol specifications, an end user must be a member of the GSA. This course was not a member of the GSA, however the future of slot machine communications was an important topic.

OpenG2S [13] is a project on sourceforge and provides Java code implementing some of the G2S features. Although this codebase does not appear to be maintained, it does provide a good foundation to describe the features and methods of the G2S protocol.

The official G2S documentation resides in a password protected section of the GSA website, however the OpenG2S project contains architecture diagrams which provide a good overview of how the entire process works. As mentioned before, the software is out of date and written to comply with a now defunct version of the protocol, but the it does provide a good example to demonstrate the transport layer as well as basic message structures.

3.5 Testing Standards

Different gaming jurisdictions require slot machines to be tested to different standards. Gaming Labs International (GLI) [4] provides testing for gaming devices for more than 455 gaming jurisdictions throughout the world. In addition to testing games for compliance with jurisdictional requirements, GLI also provides standards that different jurisdictions can choose to adopt. These testing standards are good goals for new slot machine development projects to achieve. Fortunately, GLI provides the testing standards in a public manner and they were analyzed and discussed in this class. The particular GLI standards discussed are listed below.

GLI 11 [5] provides requirements for gaming devices in casinos. It contains requirements for hardware requirements such as door locks and reporting machine access. Standards exist for checking critical memory to ensure there is no corruption due to programming errors, power surges, or unauthorized access.

Software requirements instruct developers on minimum requirements for random number generators. For example, the random selection cannot be influenced by any outside interference, and performing a "near miss" is prohibited. A near miss is a method by which symbols are rearranged on screen after an outcome is determined to give the appearance to the player that he almost received a winning combination. RNG requirements also state that all outcomes must be possible, which prevents developers from removing the possibility of hitting a large prize and keeps the game fair.

Software requirements of GLI 11 also demonstrate how gaming devices should function in the event of a hardware or software failure. There are also standards that show the minimum requirements for accounting purposes such as recording the number of games played and won along with accounting for different forms of financial instruments entering and leaving the gaming device. The standard also lays out requirements for game play history, which can be used by players and casino personnel to handle disputes over slot machine payouts.

GLI 13 [6] provides the requirements for remote monitoring and financial accounting of gaming devices. It defines what events that occur on a gaming device are considered significant, and what the back end system is required to do with these significant events. For example, when a door on a gaming device is either opened or closed, the device must report to the system that the event occurred. The system must then log in a database the date and time at which the door was opened, the gaming device that triggered the event, and a description of the event in text format in the local language. GLI 13 also describes the accounting information that a host system is required to request and store from gaming devices.

3.6 Legislation

Another great resource when looking for information about proprietary industries is government legislation. The gaming industry has had several important pieces of legislation passed at the state and federal level, and depending on the timing there could be bills in the works.

In 1988, Congress passed the Indian Gaming Regulatory Act (IGRA) [12] which set the path for tribal gaming expansion in the 1990's. IGRA established the National Indian Gaming Commission (NIGC) and regulated the conduct of gaming on Indian Lands. This document was read and analyzed by the class to provide an example of landmark gaming regulations.

With Regulation 5A [15], Nevada set the standard for internet based wagering. Although the Nevada law was somewhat limiting in the types of games that could be played outside of a casino, the regulation set the United States in a progressive motion towards the legalization of internet based gaming. Students were exposed to important and timely gaming reforms at the state level by analyzing and discussing this piece of regulation.

In addition to state laws reforming gaming operations, students were also shown important items at the federal level. Although at the time the class was offered (and at the time of this writing) no federal regulations legalizing any kind of online gambling had been passed, there were several bills attempting to make their way through the process. The class investigated the proposed Internet Gambling Prohibition, Poker Consumer Protection, and Strengthening UIGEA Act of 2011. Looking into this act unveiled how online gambling is related to the passing of The Security and Accountability For Every (SAFE) Port Act of 2006, which is an Act of Congress governing port security.

4. COURSE PROJECTS

Throughout the course, there were several projects assigned in relation to gaming. All projects in the class were written in JavaScript using the canvas element of HTML5. This approach was chosen as students would have experience developing in a new language and in a foreign environment. This is something potential employers would be interested in. In class programming assignments were completed roughly ev-

ery other week and were in sync with class discussions. The projects are listed below in the order in which they were presented to students

4.1 Simple Game

Students were given a slot machine template program and instructed to modify it. The template included a slot machine frame and symbols. The three reel slot machine was coded to switch symbols when the play button was pressed and then evaluate the pay across the center payline. Students were assigned to add a second and third payline as well as take multiple bet amounts. At the conclusion of the lab, students had a slot machine that would correctly keep track of the amount of credits on the slot machine, subtract the amount bet, and correctly evaluate and pay the player if there was a win on any of the three lines being played.

4.2 Math

This lab involved students calculating payback percentage, hit frequency, and volatility based on win amounts and frequencies of symbols. Students were instructed to craft pay amounts and their weights to produce a game that fit a specific math model, for example a game with a 23% hit frequency with a 95% payback percentage. In addition to calculating the math, students modified their slot machine from the first lab such that symbol weights matched their spreadsheet calculation in order for students to see how changing math parameters could effect the playability of the game.

4.3 Spinning Reels

This lab had students enhance their existing slot machine to have spinning reels. The previous version of the slot game would simply switch symbols out for new symbols. In this version, students were required to build reel strips matching a certain math model, and create an animation routine to make the reels appear as though they were spinning. In addition to spinning the reels, students were required to ensure their reels stopped at the reel stops the random number generator chose as well as to make sure the game paid out correctly.

4.4 Video Card Game

In the video card game lab, students were instructed to create their own card game. It could be a simple blackjack game, or poker, or any game of their invention. This turned out to be an interesting lab in that students were over confident of their abilities and their ideas were way more complex than could be completed in a two hour lab. Every student left this lab with a partially finished project. The scope of this lab should have been narrowed in order for everyone to complete it, but the openness also gave the students the opportunity to better learn how to estimate the time required to complete projects.

4.5 Pick Em

Students were required to bring to this lab a background picture and at least three elements to place on the screen. Students learned how to trigger a bonus event based on bonus symbols lining up on the payline, and transition to the bonus round. In the bonus round, students coded the

Figure 4: Student Project using OpenGL

game such that the player would receive one or more bonus picks and the total would be correctly added to the credit meter. At the conclusion of the bonus round the game returned to show the reels and play could continue. Although each student completed the same assignment, because they all used unique graphics the basic slot machines now had their own look and feel.

4.6 Progressive

In this lab, students added a progressive jackpot to the simple slot machine game. A contribution percentage was set and the jackpot was to increment by the correct amount after each play. If the correct symbols lines up the player would be awarded the accumulated jackpot amount and the progressive jackpot was correctly reset.

4.7 Central Determination

A server running on an Amazon EC2 instance was set up and would respond to a request from the games. Students were given an API to the server which consisted of a game request message and a response. When coded correctly, the game would request a prize from the system for a specific bet amount, the system would return a prize amount and the game would need to find a set of reel stops that paid that amount. At the completion of the lab, students had written a very basic instant lottery based game client.

4.8 Final Projects

All students in the class were required to do a final project. There was no specific requirement for the project, however students were required to obtain permission from the instructor prior to starting. Although the projects in the class were all completed using JavaScript and the HTML5 canvas, there were no requirements as to technologies or platforms to use for the final project. Members of the gaming industry were invited to view the presentations made by the students of their work. Some of the projects included:

- **Player Loyalty System** – This project included a monitoring system that added points to a player account for each dollar spent. A simple protocol was

developed and the client and server exchanged data via TCP/IP.

- **System Based Progressive** – A client/server approach was developed to enhance the simple progressive developed in the class project to a more traditional server based approach.
- **Central Determined Server** – Instead of using the provided centrally determined instant lotto server provided to the class, a new system was developed to deliver prizes to the client
- **3D Slot** – A slot machine application was developed from scratch using OpenGL to move and rotate the symbols (Fig. 4). This slot gave a more realistic appearance of symbols spinning around a cylinder.
- **Mobile Slot** – A slot game that included a bonus round similar to Angry Birds was developed in Java and ran exclusively on Android based smart phones.
- **Research Paper** – One student wrote a research paper analyzing the effects of online gambling on traditional casino traffic. A specific piece investigated how the brick and mortar casino traffic was effected by the passage of the SAFE Port Act of 2006.
- **Multi-Game Slot** – This project allowed players to switch game titles, while accurately maintaining both game specific and total machine accounting meters.

5. DISCUSSION AND FUTURE WORK

The pilot semester of the class contained ten students, six graduate students and four undergraduates. Within three months of the class, at least two students previously employed at a gaming company received a promotion, and at least two other students received new jobs in the gaming industry. This course is now under consideration to be offered once a year with hopes of increasing the size of the class. To better gauge the material contained within this course, surveying gaming companies about the contents of the course and the success of students who have taken the course may validate the current syllabus and may also provide insight for improvements.

6. CONCLUSION

This paper presents a class dedicated to a portion of the gaming industry that is often overshadowed by the Halos and Candy Crushes of the world. The success of the student projects and the fact that 40% of the class was either promoted or found employment directly in the industry this class was designed to educate about indicates this class could be useful for students and for gaming companies. With the anticipated increase in internet based wagering, students possessing the skills taught in this class may be in high demand.

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