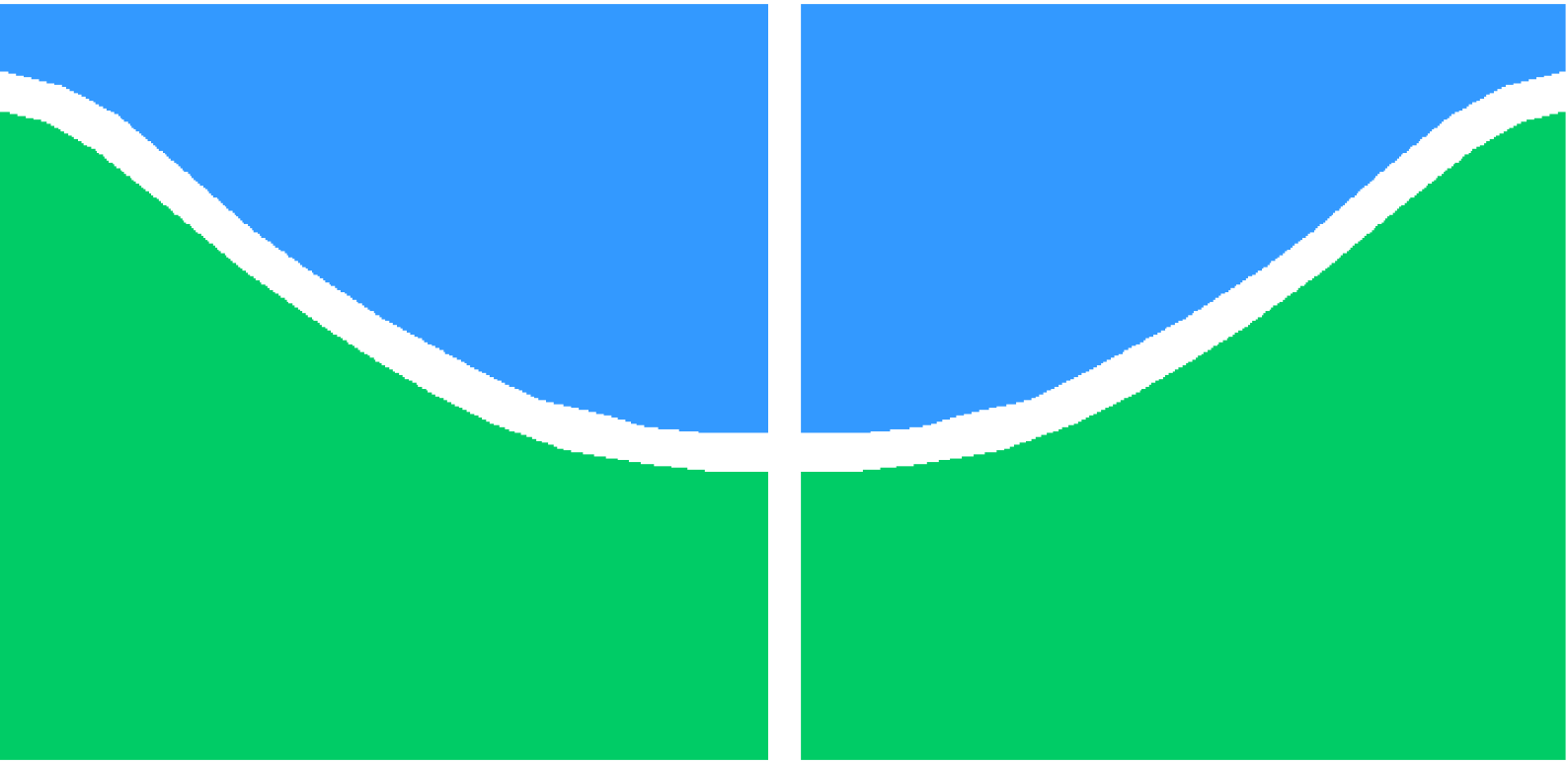

Universidade de Brasília – UnB
Faculdade UnB Gama – FGA
Engenharia de Software

UnB Games Platform: A collaborative project

Autor: Parley Pacheco Martins
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Brasília, DF
2017

Parley Pacheco Martins

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Monografia submetida ao curso de graduação em Engenharia de Software da Universidade de Brasília, como requisito parcial para obtenção do Título de Bacharel em Engenharia de Software.

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"There are some things you can't share without ending up liking each other and knocking out a twelve-foot mountain troll is one of them."
(Harry Potter and the Philosopher's Stone)

Resumo

Jogos desenvolvidos nas universidades não possuem muito reconhecimento ou suporte. Usuários raramente têm a chance de jogar tais jogos ou dar algum *feedback*, como críticas, elogios e reportar problemas, ao desenvolvedor sobre qualquer versão desses jogos. A maioria das pessoas nem sabe que jogos são feitos em salas de aula. Este projeto tem como objetivo tornar esses jogos disponíveis para o público, através do desenvolvimento de uma plataforma online. Todo o trabalho realizado numa universidade, especialmente pública, deve ser acessível a toda a sociedade, desde a concepção até a implementação, por isto, este documento descreve como este trabalho será feito, criando a plataforma para o compartilhamento desses jogos. A plataforma também possibilitará a geração de pacotes, para que o usuário consiga instalá-los sem dificuldade.

Palavras-chaves: jogos. desenvolvimento. plataforma. empacotamento.

Abstract

Games developed in the University don't have much recognition or support. Users don't usually get to play them or give a feedback about any version of any of them, either good, bad or bug reports. Most people don't even know that games are created in classes. This project aims to make these games available to people, by developing an on-line platform. Everything created in the university, especially a public one, should be accessible to the society, since its conception to its implementation. Because of that, this document outlines how this work will be achieved, by creating a platform to upload the developed games. It will also provide the building of packages to simplify the installation process for the user.

Key-words: games. development. platform. packaging.

List of Figures

List of Tables

List of abbreviations and acronyms

SDL	Simple DirectMedia Layer version 1
SDL2	Simple DirectMedia Layer version 2
API	Application Program Interface
GUI	Graphical User Interface
VM	Virtual Machine
OS	Operating System
dpkg	Debian Package Management System
rpm	RPM Package Manager
pacman	Pacman Package Manager
RUP	Rational Unified Process
XP	eXtreming Programming
FHS	Filesystem Hierarchy Standard
FGA	*Faculdade UnB Gama*
MDS	*Métodos de Desenvolvimento de Software*
GPP	*Gestão de Portfolios e Projetos*
PMBoK	Project Management Body of Knowledge
LAN	Local Area Network
indie	Independent

Contents

Introduction

Games are known to provide several benefits to the players. It may be enjoying a good story, developing new abilities and skills, bonding with friends or just relaxing after a big rushed day. Independent game developers have to struggle to achieve any of these goals, because it's so much harder for people to see their games.

There are some courses taught here in the *Universidade de Brasília* (like *Introdução ao Desenvolvimento de Jogos* at the campus *Darcy Ribeiro*; and *Introdução aos Jogos Eletrônicos* at the campus Gama) that have the goal to teach students to develop games. The students that take these have the opportunity to learn how to create a game from scratch. Several of these students wish to continue working on game development after their graduation.

The games developed in those courses usually have a good story and are good to play with, however they are never seen outside the courses because there's nowhere to put them after they are done. People also have the tendency to relate things that are done inside the classes to things that have no use in *real life*, therefore expandable.

This project was created to give visibility to these games and developers and to show the work that has and will be done in this University concerning game development.

Goals

The main goal of this project is to create an on-line platform to host the games developed in the courses of this University. The secondary goals are the following:

- allow users to download, run and distribute these games in any operating system they have;
- let the students of these courses upload their source codes and have the respective installers and packages available for the public;
- build packages to games that don't have one.

Work Structure

This document is divided in chapters. Chapter 1 explains some basic concepts for the reader. Chapter 2 given an overview of the tasks to be done and how they were achieved. Chapter 3 shows the partial results the project had so far, as well as the issues

with those results. Chapter 4 describes the next steps needed to achieve the main goal, with a brief schedule containing the estimated time to complete the tasks.

1 Basic Concepts

This chapter gives an overview on some basic concepts needed by the reader to understand this work. It starts talking about games and the SDL library, then talks a little about the GNU/Linux Filesystem, that helps developers to understand where their binaries and other files should go on the user's system. At the end, there are brief words on repositories and packages.

1.1 Games

Games have been a part of human development since their early childhood and have been part of history in its most basic ways (BETHKE, 2003). Providing a fun time, bonding with friends and learning news skills are some common goals of games. They consist on interacting with other people (or computer) or just with the game structure itself, following the rules to achieve a goal.

They can take several formats, like board and card games, for example. Each format has unique strategies to win. To illustrate that, take the two cited examples: board games usually divide the user space in sectors, and everything is related to which sectors you are in and how you control them; card games, however, rely on the symbols and possible combinations of them (CRAWFORD, 1984). To win the former type, a player has to understand the cost to acquire/leave sectors and plan accordingly, while on the latter, one needs to watch their symbols and try to get the best combination out of them.

Since computers were invented they completely changed the gaming world. New kind of games, like *first person shooter* and *tower defense*, were created and made popular, while it became possible to play virtually the ones that required a physical board or a lot of people. With the Internet, it became even easier to own and play different games. It's also possible to play any kind of game with anyone in the world.

Because computer games are software with audio, art and gameplay, they should follow a software development method, any one chosen by the team. This is something that most game developers avoid, because they see their work as pure art (BETHKE, 2003). Although that is certainly true, a game has everything a "normal software" has and more, therefore requiring a known development process or method. Using software engineering techniques (adapted to their needs, naturally) will result on a better game and better interaction with the final user (PRESSMAN, 2010).

1.2 SDL

Digital games have many things happening at once. There is sound playing, they must be able to receive and response to inputs from the player, coming from different sources sometimes, and, while all this is happening, they must also keep rendering the scenario and show the statistics of the user. To simplify that, developers use several libraries in their source codes, one of the most popular being SDL.

Simple DirectMedia Layer (SDL) is a library that helps developers by creating cross-platform APIs in order to make easier handling video, input, audio, threads. It's used in several games available in big platforms like *Steam* and *Humble Bundle* (SDL, 2017). In order to be fully integrated with the developer's code, a few files are needed during the compilation: the headers, that contains definitions of functions and structures; and the library itself, that contains the binaries that will run with the main code, and may be static and shared (MITCHELL, 2013).

A shared library is one that can be used in multiple programs. It provides common code that is reusable and can be linked to the developer's code at running time. On GNU/Linux systems they have the *.so* file extension, while on Windows they have *.dll* (CAMPBELL, 2009). In this case, the library code is not merged to the main code, resulting in a smaller binary for the developer. It's required to have the library installed in the user's system, though.

The static library is compiled against the main source code and it's merged to it. Instead of being a dependency on the user's system, it's now a part of the distributed version of the software, resulting in a bigger binary. The new license on SDL2, *zlib*[1], allows users to use SDL as a static library, however they are not encouraged to, because that wouldn't provide several things the user might need. For example, security updates that come on the new patches, wouldn't be available to a game that has SDL built into it (GORDON, 2017).

1.3 Filesystem Hierarchy Standard

When installing a game, it must go somewhere in the filesystem of the user. For games developed to run in the GNU/Linux environments, they should follow the patterns found in FHS. The Filesystem Hierarchy Standard (FHS) was proposed on February 14, 1994 as an effort to rebuild the file and directory structure of Linux and, later, all Unix-like systems. It helps developers and users to predict the location of existing and new files on the system, by proposing how minimum files, directories and guiding principles (BANDEL; NAPIER, 2001).

[1] The text of this license can be found at <https://www.zlib.net/zlib_license.html>

The Hierarchy starts defining types of files that can exist in a system. Whenever files differ in this classification, they should be located in different parts of the system: *shareable* files are the ones that can be accessed from a remote host, while *unshareable* are files that have to be on the same machine to be obtained. *Static* files are the ones that aren't supposed to be changed without administrator privileges, whereas *variable* ones can be changed by regular users (BANDEL; NAPIER, 2001)

The root filesystem is defined then: this should be as small as possible and it should contain all the required files to boot, reset or repair the system. It must have the directories specified on Table 1 and installed software should never create new directories on this filesystem (ALLBERY et al., 2015).

Table 1 – Directories on the Hierarchy (ALLBERY et al., 2015)

Directory	**Description**
`bin`	Essential command binaries
`boot`	Static files of the boot loader
`dev`	Device files
`etc`	Host-specific system configuration
`lib`	Essential shared libraries and kernel modules
`media`	Mount point for removable media
`mnt`	Mount point for mounting a filesystem temporarily
`opt`	Add-on application software packages
`run`	Data relevant to running processes
`sbin`	Essential system binaries
`srv`	Data for services provided by this system
`tmp`	Temporary files
`usr`	Secondary hierarchy
`var`	Variable data

From the directories in Table 1, "`/usr`, `/opt` and `/var` are designed such that they may be located on other partitions or filesystems." (ALLBERY et al., 2015). The `/usr` hierarchy should include shareable data, that means that every information host-specific should be placed in other directories. About the `/var` hierarchy, FHS specifies that "everything that once went into `/usr` that is written to during system operation (as opposed to installation and software maintenance) must be in `/var`." (ALLBERY et al., 2015).

The Hierarchy has some optional defined places to put the binaries of the installed games, like `/usr/games`, or `/usr/local/games`. The difference between the two is that the former is where the package manager installs, while the other is usually where packages compiled locally are installed (TEAM, 2017). Variable data, as usual, should be inserted into the the `/var` filesystem, under `/var/games`.

1.4 Repository

Game development, as has been said, demands special care with the source code. Like any software, when a bug is accidentally inserted, there should be an easy way to return to a previous state, where that didn't happen. The solution to this problem is using a repository for the source code.

According to the Merriam-Webster Dictionary (2017), a repository is "a place, room or container where something is deposited." A software repository is a computer, directory or server that stores all the source code for that software project. This is usually available on the Internet, but it can also be local to the developers.

Repositories are also related to the version control of the source code being produced. The definition of version control is "a system that records changes to a file or set of files over time so that you can recall specific versions later" (LOELIGER; MCCULLOUGH, 2012). This allows the user to compare versions, to check updates, see who introduced (or removed) an issue and to rollback to previous versions of the system (CHACON; STRAUB, 2014). The goal is to make it easy to return to states that were working, even after changes are made after a long time.

Modern version control systems allow developers to work on a distributed basis and to parallel their tasks, with the ability of *branching* the repository. Those *branches* are separated lines of development, that won't mess with the main one until they are merged (WESTBY, 2015). This feature lets developers create and test new changes before submitting them to the project stable line of work, without affecting the final product.

1.5 Packages

In computer science package can have multiple meanings, depending on the context being used. A GNU/Linux package means a bundle of files containing the required data to run an application, such as binaries and information about the package. Game packages behave exactly the same as any other software. To facilitate installing software, GNU/Linux has package managers.

Most Linux distributions have their own package managers. Each expects and handle different types of files, but all of them have the common goal of making the installation easier. They download the package, resolve dependencies, copy the needed binaries and execute any post- or pre-configuration required by the system to install a package (LINODE, 2017). For example, Debian has *dpkg*, Red Hat has *rpm* and Arch Linux has *pacman* as default package managers.

Another installing method is compiling from scratch. This may be very handy if the user is more advanced or the package is not in the package manager's repository.

However, in this case, the user will have to manually handle dependencies, download, compile and do everything else the manager does.

1.5.1 CMake

Creating packages for multiple platforms requires a lot of time and effort, because it has to be compiled on each of the systems, with those system's libraries, binaries and architecture. In order to make this task easier, several cross-platform building tools were created.

CMake was created to fulfill the need for "a powerful, cross-platform build environment " (CMAKE, 2017) for a big American company. This project, developed by Kitware, was open source and grew from that to be a build environment for any purpose, powered by Kitware. It is "a system that manages the build process in an operating system and in a compiler-independent manner" (CMAKE, 2017).

In a very clever way, CMake generates native compiling and configuration scripts (like makefiles for Unix and namespaces for Windows) and use them to build the package. It is also designed to be used with the native environment, unlike other building tools (CMAKE, 2017).

The building process is controlled by files named `CMakeLists.txt`. They can have commands to generate a building environment, set needed variables, compile dependencies, link required libraries and install the project. A project that has many subdirectories, each with their own rules, can have multiple `CMakeLists.txt` to create the final product.

1.6 Related Work

There are several platforms to share and distribute games on-line. Amongst the most popular ones, there are Steam, GOG and Humble Bundle. They have thousands of games, including indies, with great support of the gaming community. Some of them are described here as an inspiration to this work.

Steam was announced in 2002, and released in 2003. Valve saw the need that many games needed to run on an up to date environment and decided to create a system that would target that issue (WIKIPEDIA, 2017b). The website has the purpose to be the store for the platform, while the system is actually installed on the player's machine and needed to play the games made available by them. Today, they have a huge community, cross-platform (Linux, Mac, mobile devices and consoles) system with many games and extra content for them (STEAM, 2017).

GOG started out with the name *Good Old Games* trying to provide DRM free games to people. It was released in 2008 and has been active ever since (with a brief down

period in September 2010). Since March 2012, it has been rebranded and independent games have been added to their library (WIKIPEDIA, 2017a). They also have a system, like Steam, but this one is not required to run the games, it was built though to provide easy sharing and buying of games, among other things (GOG, 2017).

Humble Bundle is a platform that provides a bundle of games (books, software and other things) to the public at very low prices. Part of their profit is destined to charity (the buyer can also choose where their money goes) and they have already raised more than 98 million dollars for that purpose (BUNDLE, 2017). They also provide a store with regular prices and games.

Splitplay is a Brazilian platform specialized in indie games. They realized that several indie developers couldn't bring forth their games and decided to create a place where those would be publicize them in their own platform. Splitplay allows developers to send their games complete or incomplete (as a project), they can be free or paid. The site creators personally overview the submissions and don't charge developers (SPLITPLAY, 2017).

2 Methodology

This chapter explains what was done within the duration of the whole project. Section 2.1 gives an overview of the whole project and its goals. Section 2.2 explains how the work was divided between all parties involved in the development of this project. Section 2.3 shows how and which games were selected for both parts of this work. Section 2.4 clarifies how the packaging template were created and its main parts. Section 2.5 illustrates how the platform was developed. Section 2.6 references the tools that were used to create and test everything the project has aimed to create.

2.1 Project Overview

The project has the main goal of creating a platform for all the games developed in the university's courses related to games. The games that will be available must have all their assets and required libraries in packages that run on some GNU/Linux, Windows and macOS systems.

In order to achieve this goal, the games developed in this campus of the University were cataloged and cloned into a main GitHub organization (whenever possible). A template system was created to package the files for each one of the contemplated Operating Systems.

The platform itself was developed while all the other activities took place, during the first half of this work. Some games were chosen to test the template, but it's main use will be during the new development cycle inside the game courses.

2.2 Task Division

This project is totally collaborative, it depends and relies on different classes and courses. Because of that, during the first half of it, the work was divided among students and teachers, as illustrated in Figure 1.

Professor Edson and Mr. Faria were responsible for first cataloging the existing games. They remained as helpers in the packaging system and main stakeholders for the team that developed the website.

The team *Plataforma de Jogos UnB* from the courses *Métodos de Desenvolvimento de Software* (Software Development Methods) and *Gestão de Portfolios e Projetos* (Management of Portfolios and Projects) was in charge of creating the first version of the

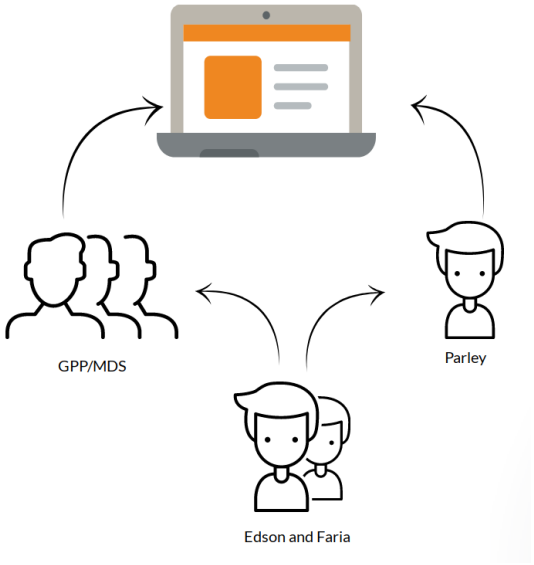

Figure 1 – Task Division

actual website with some of the features desired. The names of all the members are in the Appendix A.

Before the second semester of the project, professor Edson developed the packaging template. During this term, my responsibility was to test this template in a few selected games and to evolve and maintain it, as well as to maintain and add some features to the platform developed in the previous semester. Professor Edson and Mr. Faria were code reviewers and helpers in the system.

2.3 Game Gathering

The games selected for the first part of the project were the ones developed in this department, *Faculdade UnB Gama* that is the Gama Campus of the University, since the course *Introdução aos Jogos Eletrônicos* (Introduction to Electronic Games) has been created here in the first semester of 2012. Professor Ricardo Jacobi was the first to teach the course, but it wasn't possible to contact him or get the games developed in that term. Professor Edson taught the course after that, until 2016. It has been assumed by Mr. Matheus Faria, since the beginning of this year (2017).

Because this work is being mostly held at FGA, and all the games developed here are compiled and run on Linux distributions, these were selected as first games for the platform. Another reason for this choice is the proximity with the students who created those games.

Professor Edson and Mr. Faria first contacted the students and asked them to post

their codes to GitHub. They cloned them into the `fgagamedev`[1] GitHub organization.

After that, I was responsible for checking the status of the games, gathering information such as which of them compiled, which SDL version they used, which ones had licenses. Table 2 shows these initial results.

Table 2 – Initial status of the selected games

Name	**Source?**	**License?**	**SDL**	**Compiles?**
Deadly Wish	y	n	2	n
Strife of Mythology	y	n	2	y
Travelling Will	y	n	2	y
7 Keys	y	MIT	2	n
Babel	y	GPL 2	2	y
Terracota	y	MIT	2	n
Dauphine	y	n	2	n
Imagina na Copa	y	n	2	y
Kays Against the World	y	n	2	y
Ankhnowledge	y	GPL 2	1	y
The Last World War	n	-	-	-
Post War	y	n	1	y
War of the nets	y	GPL 2	2	y
Jack the Janitor	y	GPL 3	1	y
Drawing Attack	n	-	-	-
Earth Attacks	n	-	-	-
Emperor vs Aliens	y	n	1	y
Ninja Siege	y	GPL 2	1	y
Space monkeys	y	GPL 2	1	n
Tacape	n	-	-	-

Out of 20 games created in *Introdução aos Jogos Eletrônicos* while Professor Edson taught it, 4 didn't have a known repository and 8 didn't have a license that allowed us to change them at that time. Mr. Faria and I were responsible for finding unknown games and getting the missing licenses. As result of this task, *The Last World War* was added and 5 other had licenses acquired as shown in Table 3.

In the second semester, to test the new packaging template, four games were selected out of those previously chosen, two developed with SDL and the other two made with SDL2: *Ankhnowledge*, *Ninja-Siege*, *Travelling Will*, and *Deadly Wish*, respectively. These games were chosen because they already worked correctly without any need to change their source code.

[1] https://github.com/fgagamedev/

Table 3 – Game status after contacting developers

	License	**SDL**	**Compiles**
Deadly Wish	GPL 3	2	n
Strife of Mythology	GPL 2	2	y
Travelling Will	MIT	2	y
7 Keys	MIT	2	n
Babel	GPL 2	2	y
Terracota	MIT	2	n
Dauphine	MIT	2	n
Imagina na Copa	MIT	2	y
Kays Against the World	n	2	y
Ankhnowledge	GPL 2	1	y
The Last World War	n	1	y
Post War	MIT	1	y
War of the nets	GPL 2	2	y
Jack the Janitor	GPL 3	1	y
Emperor vs Aliens	n	1	y
Ninja Siege	GPL 2	1	y
Space monkeys	GPL 2	1	n

2.4 Packaging

The template for packaging was created by professor Edson is based on two main directives, modularisation and platform independence. The first one is related to dividing the directories by topic, meaning that, each folder will be responsible for one thing and all the files inside of them should be related to that specific thing. The second directive, platform independence, is to make the development for multiple platforms easy. Each directory will have a division for each of the platforms.

To achieve the template modularisation, professor Edson decided to use a folder structure that would be easy to understand to anyone familiar with GNU/Linux FHS, with a few additions. Apart from the original directories in the repository, he added the folders `bin`, `dist`, `lib` and `scripts`. This structure is represented in Figure 2

- `scripts` this is where the scripts to build, package and distribute the binaries for all the platforms will live. It also has a subdirectory called `utils` that holds some specific platform scripts, like generating each installer, or gather information about the host OS;
- `lib` All the third-party libraries should live here. The scripts to build the code are already set to look for libs inside this directory, being each subdirectory a dependency;
- `dist` This contains the files needed to generate the packages for each platform;

- `bin` has all needed libraries and the game executable.

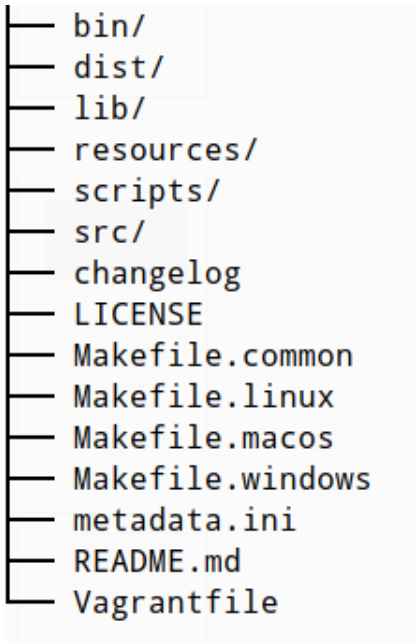

Figure 2 – Folder tree

The second directive was met by dividing some of the directories into platform limited directories, making the code that lives there accessible only when running on that individual platform. Any file outside the platform directory is considered generic and can be used for any Operating System. For example, when running on Windows, the compiler would only access generic files and Windows specific ones, like `dlls`. The same thing happens for macOS and GNU/Linux systems. This division is represented inside the `lib` directory in Figure 3.

As also seen in Figure 3, inside each platform folder (only for libraries) there is yet another division to make sure the template can generate different versions of the program for `debug` and `release`. The binaries that live on `release` are stripped of all debug symbols, resulting in smaller versions of those dependencies. Library headers go inside `include` and a compressed file with the source goes inside `src`.

The scripts kept in the `scripts` directory are the backbone of the template. Through them it's possible to compile (creating a new executable with all the dependencies locally available), run and package a game. As long as the other files are placed correctly, the scripts work properly. There are four main and seven auxiliary scripts to accomplish these tasks, that are listed in Figure 4 and described below.

- `build.sh` builds the executable, being possible to choose which is the desired version, `debug` and `release`. Calls the appropriate `Makefile`, depending on the version and platform;

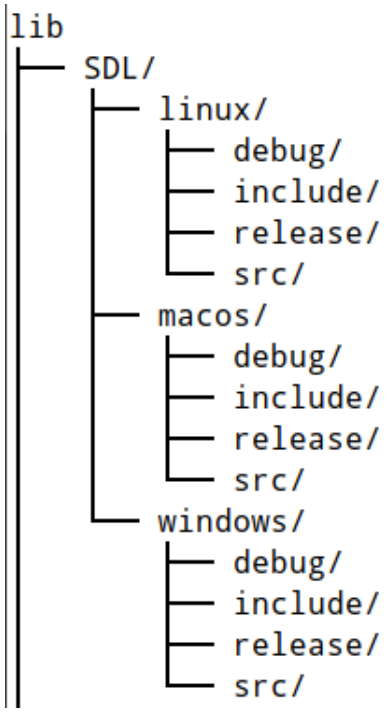

Figure 3 – Library division

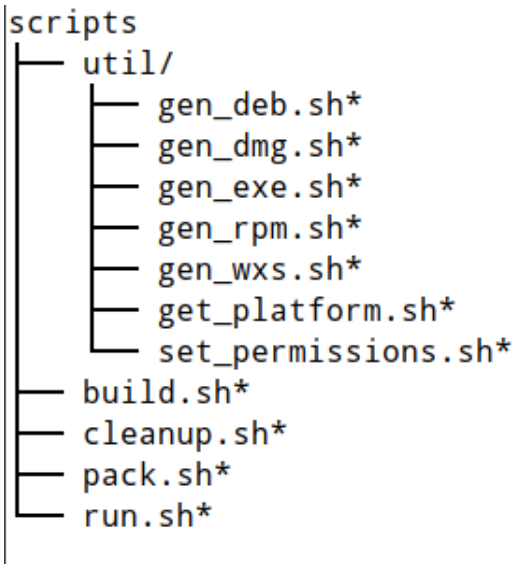

Figure 4 – Scripts

- `cleanup.sh` clears the repository, removing files generated during build and packaging, like object files and installers;
- `pack.sh` builds the release version of the program (by calling `build.sh`) and generates the installer for the specific platform it's running on. It's important to notice that it's not possible to generate a package for a different platform from the same host system, this means that, for example, to generate Windows packages, this script must be called from within Windows and not from a linux machine;

- `run.sh` runs the generated executable, setting the correct environment variables and pointing to where the local libs are. Attempting to run the program without this script may lead to errors;
- `util/get_platform.sh` checks and returns the current platform;
- `util/set_permissions.sh` sets files to 644 permission and folders to 755 inside a given directory;
- `util/gen_deb.sh` generates a `.deb` file to be installed in Debian-based systems;
- `util/gen_rpm.sh` generates an `.rpm` file to be installed in Red Hat based systems;
- `util/gen_exe.sh` generates the `.exe` and `.msi` to be installed on Windows systems;
- `util/gen_wxs.sh` This is called from `gen_exe` to create a `.wxs` file, that will be used to create the Windows intaller.
- `util/gen_dng.sh` creates the `.dmg` file for macOS.

All the scripts described in this section must be executed from the root folder of the repository. All paths inside the scripts are relative to that directory and running them anyplace else may cause unwanted errors.

2.5 Platform Development

The first version of the platform was developed using mixed development methods. During the first half of the semester, the Rational Unified Process and the PMBOK were used. For the next part, Scrum and XP were chosen. This choice of development framework is because of how the courses are divided.

Throughout the RUP part of the development, the team created several documents to aid the development cycle, such as vision, architecture document, class diagram, use case diagram, use case specification, test case specification.

These documents helped the team to understand the system requirements and how they should be implemented as seen in Figure 5. The most experienced members also helped the others to learn the technologies to develop the website.

As the second part of the development started, they had to work on a totally different mindset, with new roles and documents needed. Instead of having managers, the team had now Scrum Master, Product Owner, and the Developing team (AGILE42, 2017). A Scrum Master is the responsible for protecting the team, making sure knowledge is being shared and Scrum is being followed (ALLIANCE, 2017). It's important to notice

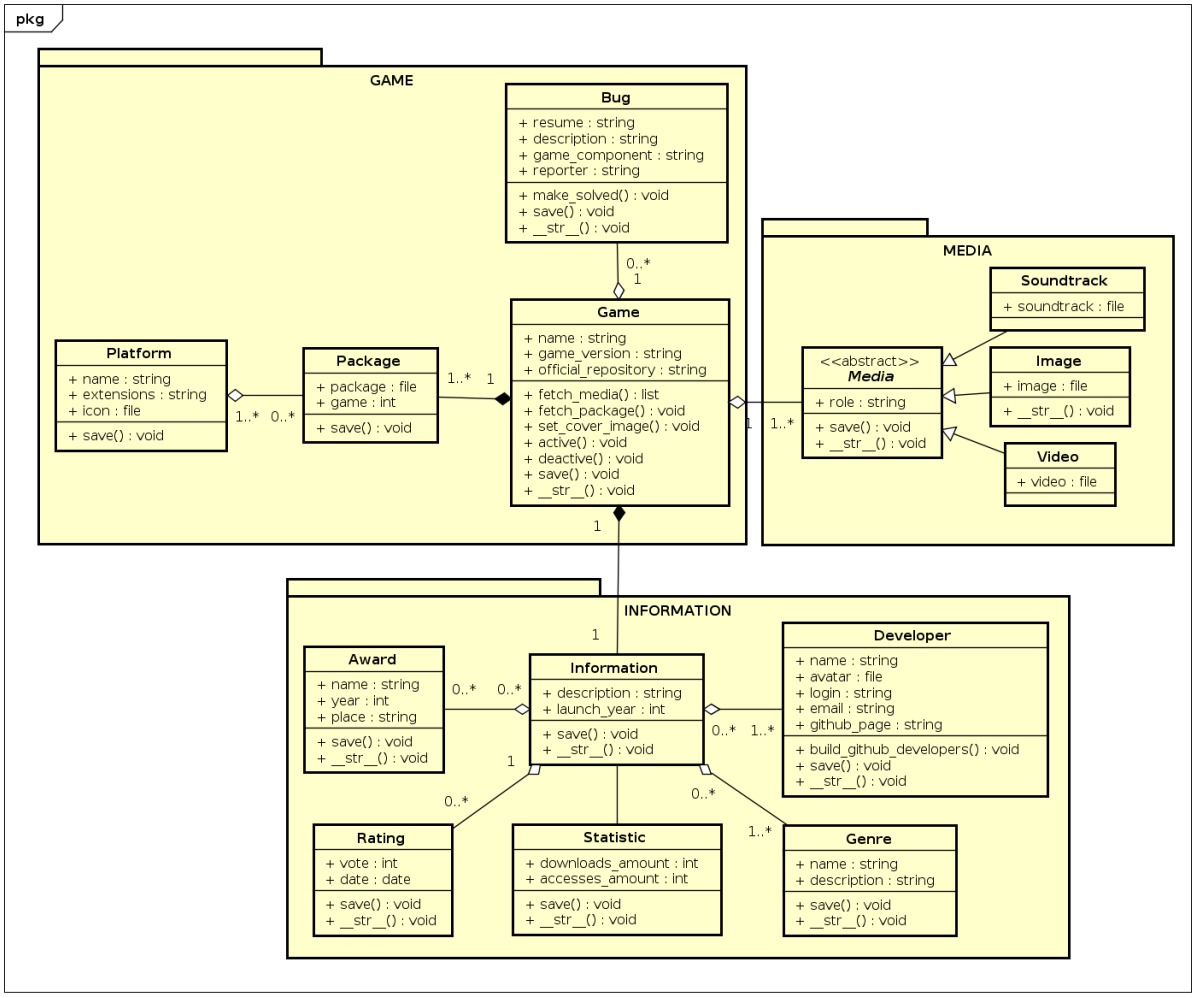

Figure 5 – Class Diagram of the Platform (UNB, 2017)

that this is not equivalent to a traditional manager, that usually only bosses around the team, not caring about the people.

Product Owner is the one who will say the product value, sets the priorities and decides what need be done (AGILE42, 2017). They must assure the work meets their expectations without controlling the development team (ALLIANCE, 2017). The Development Team are the people who will actually do the work, they don't have a manager, they act collectively and decide how they will achieve what has to be done (ALLIANCE, 2017).

For the next semester, I'll be the responsible the development and maintenance of the platform. It's intended to use Agile Practices for the rest of the development, whenever possible, but that won't be a requirement since I'll be mostly working alone on these tasks. A more detailed account of what will be done can be found in Chapter 4.

2.6 Tools

GNU Make was the chosen software for generating the packages. It's supposed to help developers managing their applications and they can run on several platforms, like Linux, Mac, and Windows. It is distributed under GNU General Public License version 3 and the minimum required version is 4.0.

The chosen compilers were `gcc`, for Linux, distributed under GPL3, with at least version 5.0; `Visual Studio Compiler`, for Windows, shared with a Microsoft community License, version 2017; and `clang`, for macOS, distributed under BSD License.

For the website development, Django was picked because of the previous knowledge the group had with it. To make the front end of the application, Facebook's React was chosen for the flexibility it gives to the user interface. They are both very scalable, have a big support in the community and are released under the BSD 3-clause license. The versions being used are the last ones at the beginning of the project, namely, 1.11.1, for Django, and 15.5.4, for React.

To develop and test the template, virtual machines running Debian Jessie and CentOS 7 were used. The VMs were powered by VirtualBox 5.2, released under GPL2, that allows easy environment virtualization. It also enables a developer to test in several operating systems, which is required for the nature of this project. The computer hosting the vms and used to has an Intel Core i5-6200U 2.3 GHz processor, 8 GB of RAM and a NVIDIA GeForce 940M graphic processor.

3 Results

This chapter explains the results obtained so far with the project development.

3.1 Template

One of the goals of this work was to generate a template that allowed the game developers from the courses of this University to create their games and easily generate packages to install in major Operating Systems, namely, Windows, macOS, Debian-based and Red Hat based distributions of GNU/Linux. This template was made by professor Edson. I had the responsibility of testing it in a few games, evolving and maintaining it throughout all the platforms.

The template consists of a series of Bash scripts, Makefile, libraries and a directory structure that is supposed to be followed by anyone who wants to use it. It is intended to be used as a template for new games developed in the courses taught at this University and it contains the most common libraries in game development, like SDL, SDL_image, SDL_mixer.

3.1.1 Root directory

Currently, there are seven required files on the root directory, specifically, `LICENSE`, `Makefile.common`, `Makefile.macos`, `Makefile.windows`, `Makefile.linux`, `Vagranfile`, `changelog`, and `metadata.ini`. These files assure compilation is possible in any platform and also give some information about the project. An explanation of what each of them does and what information each may or may not have is given bellow. Some extra optional files are also explained.

- `LICENSE` *Editable.* This should be the text of the license or a reference to a file that has the full text. Debian packages complain if this file is the actual license text for common licenses, therefore it may be better option to only refer to a file inside the system (usually `/usr/share/common-license/LICENSE`);
- `Makefile.macos`, `Makefile.windows`, `Makefile.linux` *Uneditable.* Each of these files sets variables with specific for each system, like `CC` and `DEBUG_FLAGS`. If a variable isn't needed 's just left blank. The template is supposed to work with values as they are and users shouldn't change them unless they *actually* want a different behaviour.

- `Makefile.common` *Partially editable.* Sets some other variables, common to all OSs, like `LDFLAGS`, based on each platform Makefile. The template has set default SDL libs (SDL, SDL_image, SDL_mixer, SDL_ttf), but other external libs may be wanted. When this happens, the user should add the libs wanted to the variable `EXTERNAL_LIBS` without quotes and separated by simple space. Each of these libs must be a directory inside the `lib` folder. The rest of the file should not be changed since it may lead to major errors when using the template unless the user is totally sure of how it works.

- `Vagranfile` *Optional.* This file creates two Virtual Machines running Debian and CentOS. If the user wishes to give support for them both (generating both `.deb` and `.rpm` packages), they could either use the VMs or run the template natively on each system. The virtualization provides an easier way to do that, but it is up to the user deciding this detail of the development cycle.

- `changelog` *Editable.* When creating the Debian package, it needs a changelog, that registers what was changed from the previous versions, much like a commit message. There are ways of generating this file automatically because its syntax is very particular, but the template doesn't contemplate it yet.

- `metadata.ini` *Editable.* As the extension suggests, *ini* stands for *initialization*. This is a configuration file that follows the `ini` syntax. It defines some project properties that will be used in several steps, like building and packaging, making it a very important file to correctly use the template. The user should change this file with the appropriate information as soon as cloning the repository and throughout the development.

3.1.2 `src`

The directory that holds all source code, including headers, is called `src` and is divided in two subfolders, `engine` and `game`, as shown in Figure 6. Both of these directories have the same structure, that is explained below, along with the files outside them.

- `main.cpp` *Partially Editable.* It is where the function `main` should live. This file must not be renamed or moved to inside any of the subdirectories. Users should add their own logic to it, with all the relative includes. Because of compatibility issues with Windows, there is a function called `WinMain`, that only calls the main function and should not be touched.

- `Makefile` *Uneditable.* This makefile is called during the build process, from inside `Makefile.common`. It builds the final executable, linking main with the game library, engine library, and the libraries inside `lib`.

- `{game,engine}/include/*` *Editable.* These are the header files for the engine. The template already has one header, that should not be removed, but may be renamed if the correct references are made after that. This header defines the function `resources_dir_path`, that is very important to keep the template ability to run in multiple platforms.

- `{game,engine}/src` *Editable.* The implementation of all header functions should go inside this directory. Under this there are three other directories that are supposed to hold platform specific implementation, namely, `linux, windows,` and `macos`. Any code outside them is considered to be generic and can be used in any of these plaforms. Every piece of code specific to one of these systems should be placed under the corresponding folder. The template already has specific implementation to find the `resources` folder that may be renamed or reimplemented. It is not advised to change the `macos` implementation though, except for the directory name.

- `{game, engine}/Makefile` *Uneditable.* Called from the `Makefile` in the `src` directory. Responsible for building each of these two libraries. If the folder structure was followed correctly, there is no need to change the contents of this file.

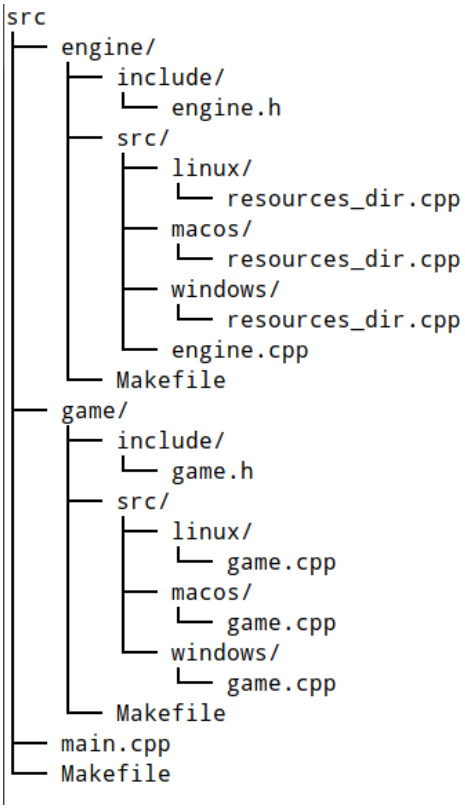

Figure 6 – `src` directory

3.2 Platform

The team developing this first version of the platform was able to integrate Django and React with some difficulty. Both of the technologies chosen are very well established on their own. Putting them together, however, is another matter, where they had a real hard time to make everything work right. They used React as the main user interface and Django Admin package to create the administrator part of the game.

The website as of now allows an administrator to upload a game, with its respective information, like supported platform, related media, and installers. The administrator has to manually add all the information related to a game, like developers who worked on it, awards won (if any), release date, version number, etc. Figure 7 shows part of the screen to add a game.

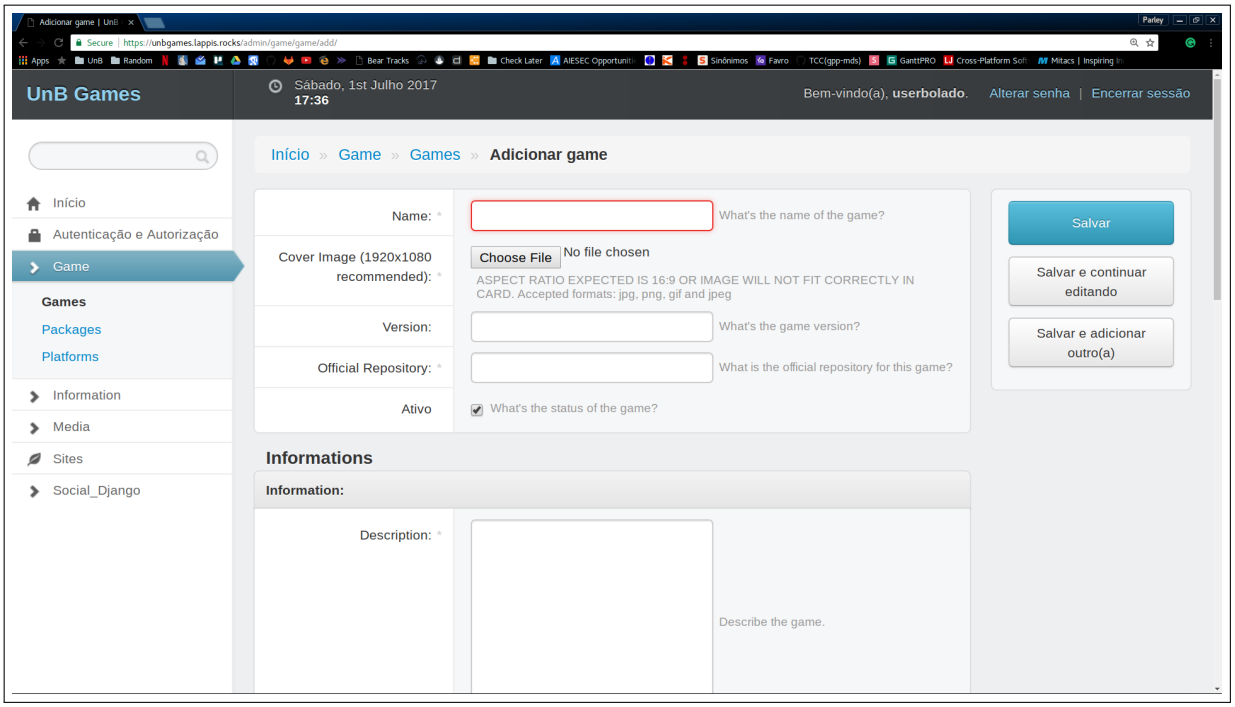

Figure 7 – Include new game

The general public can see a list of the available games, with their uploaded pictures. The home page also shows a slide with some pictures of highlighted games. By choosing one, it's possible to see its version, official repository, release date, description, among other information.

Some other features of the platform are the possibility to download the game for the available operating systems or comment using a Facebook account, as shown in Figure 8. It's also possible to categorize the games and apply several filters to them. The user can search for a specific game by its name or description as well.

The team reported they had some problems in their inner communication on this first part of the project. They are 13 people, while 5 were the managers and 8 were developers. For people without any experience in managing and with a very detailed and demanding process, like RUP, they said it was hard to balance everything.

They also said that the transition from one process to the other was a little hard, especially the role change, holding the meetings and making sure Scrum/XP were being followed correctly. The communication problem they had in the first part was mitigated in this second part of the semester, but their main difficulty now was scoring the User Stories.

They declared that, beyond all the struggling that has been detailed above, they were too naive to choose React and Django for the development of the platform. This integration is not something very trivial for experienced programmers in both frameworks, it was even harder for developers that didn't have any experience with any of them. They said it was hard to manage everything that had to be done, learn the new technologies and still merge them together.

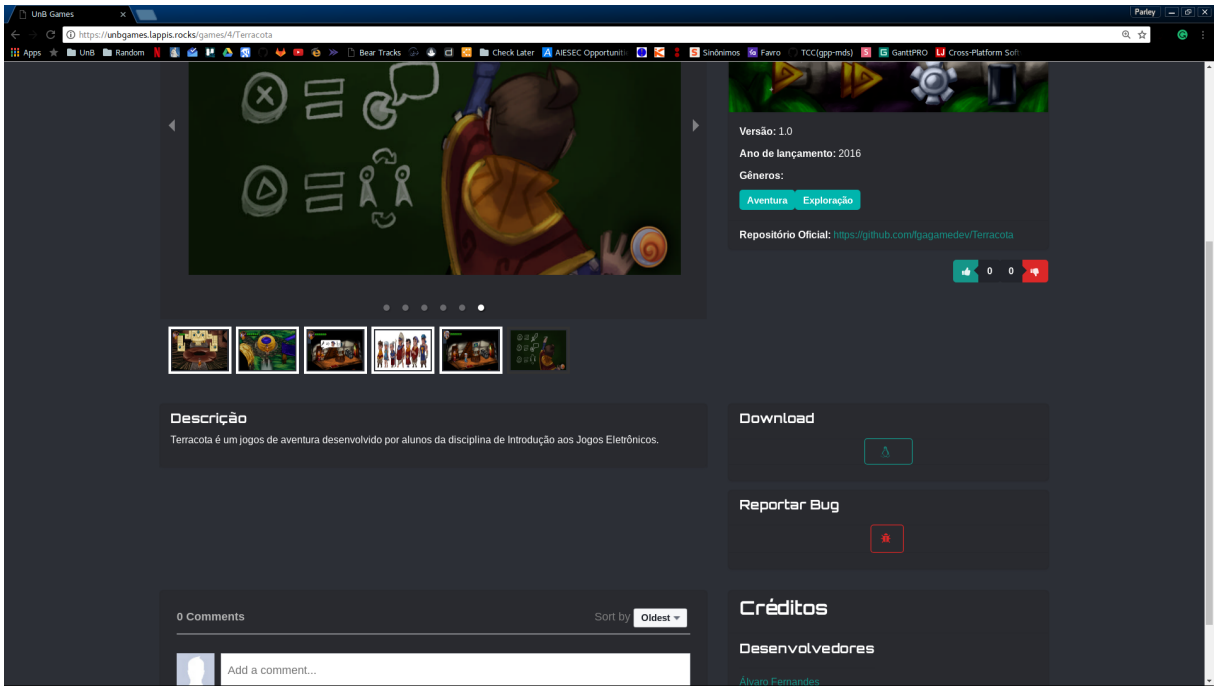

Figure 8 – Game detail

3.3 Known Issues

4 Future Work

This chapter explains what will be done in the remaining time of the project. It talks about some of the long term goals and the activities that will be carried to achieve them.

4.1 Schedule

For the next months it is expected to have the script for SDL2 projects finished with support for Windows and MacOS. The known issues described on Section 3.3 have to be fixed for both SDL 1 and 2. The building scripts have to be tested against all the available games.

Another goal is to allow the user to link their GitHub repository to the website, letting them build the packages for the game automatically with GitHub hooks. The game will then, be available in the website without the need for a manual upload from an administrator.

It's also purpose of this next part of the semester to maintain and evolve the platform while the tasks related to the script are being held. Some selected issues will be resolved to add new features and fix bugs found on the system.

The following activities will be developed in the remaining time of the project. They are summarized in Figure 9.

1. **Literature Review**: review what the literature has on packaging, CMake, game development.
2. **Add Lua support**: some of the games, especially the ones built with SDL2, have lua as a dependency library. This lib is not being being compiled in the current version of the building scripts.
3. **Add other Linux distros support**: allow other users to install the games using their package manager. Generate at least *.rpm* packages in addition to the *.deb* already generated.
4. **Add Darcy's games**: look for games developed at Darcy Ribeiro campus and run the building scripts on them.
5. **Add MacOS support**: create install packages for Mac (Apple Systems).

6. **Add Windows support**: make an installer (*.exe*) to run on Windows 10 (maybe with some backwards compatibility if possible).
7. **Integrate to platform**: run the scripts though a request on the website
8. **Avoid duplication on save**: according to the GitHub repository of the team, models are being saved with duplicated data.
9. **Create games statistics**: create endpoints to send game statistics, like views and download amounts.
10. **Submit issues to the GitHub repository**: allow users to submit issues through the platform to the GitHub repository of the game.
11. **Integrate to GitHub**: make the system receive GitHub signals.
12. **Allow user to build a game from a branch**: et the user upload a game based on a chosen branch. This will in fact run the script to build the game, but without the need of a an administrator.
13. **Read game info from game branch**: developers, description and even some images are usually available in the game repository. This task is to read that information to avoid the need of manual input of the administrator.
14. **Code refactoring**: integrate scripts (SDL 1 and 2), make them more generic and efficient.
15. **Final adjustments**: make minor improvements and fixes.
16. **Write Report**: report progress and results.

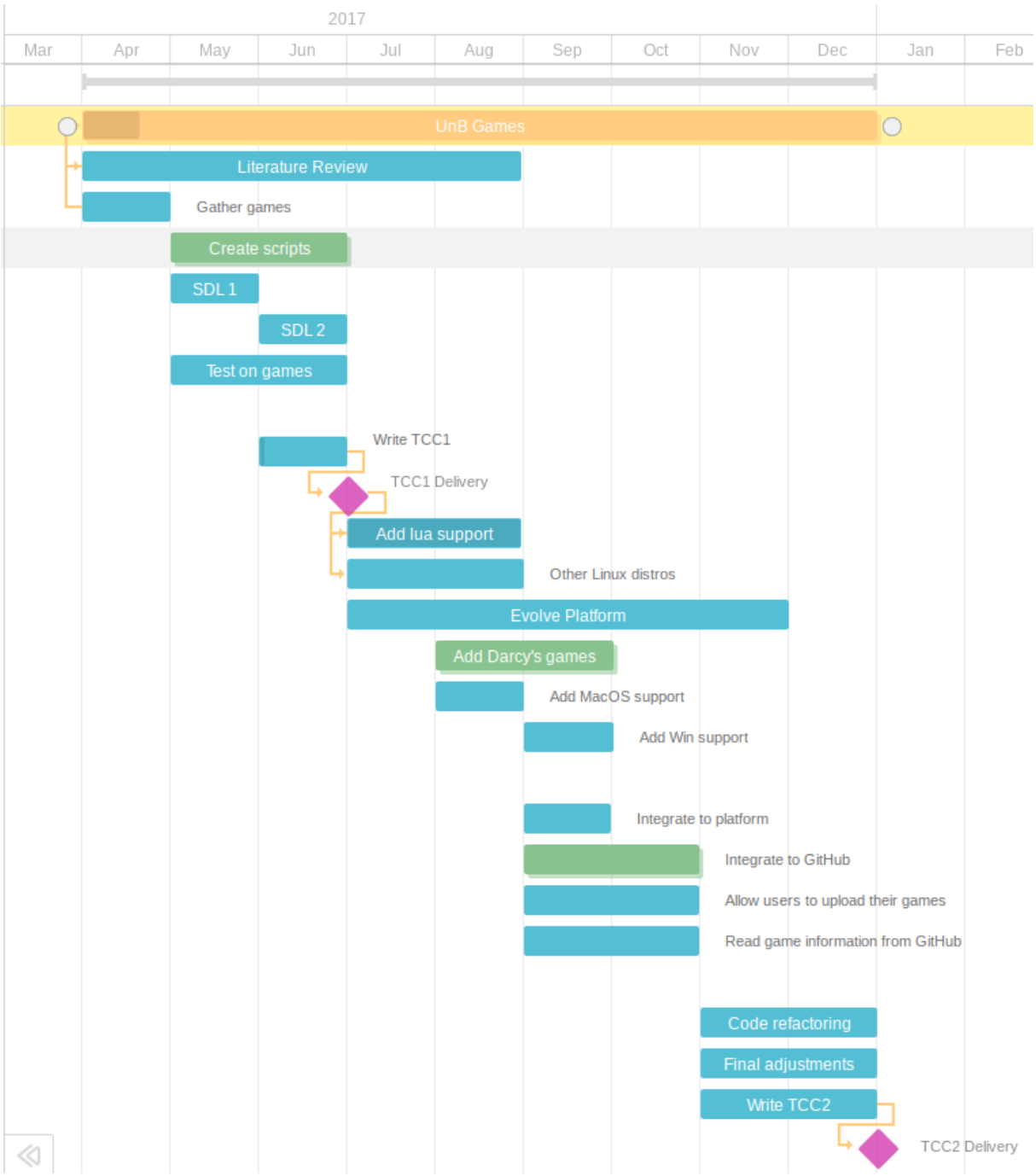

Figure 9 – Project Schedule

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Appendix

APPENDIX A – Members of GPP/MDS team

The following students were the direct responsible for developing the first version of the platform. They are students of the courses *Métodos de Desenvolvimento de Software* and *Gestão de Portfolios e Projetos* ministered by Professor Carla Silva Rocha Aguiar.

- Arthur Temporim
- Artur Bersan
- Eduardo Nunes
- Ícaro Pires de Souza Aragão
- João Robson
- Letícia de Souza
- Marcelo Ferreira
- Matheus Miranda
- Rafael Bragança
- Thiago Ribeiro Pereira
- Varley Santana Silva
- Victor Leite
- Vinicius Ferreira Bernardo de Lima

APPENDIX B – Selected games

This appendix shows the authors, year of publication, quantity of players, genre and description, whenever possible, of each selected game for this first part of the project.

B.1 Jack the Janitor

Authors: Athos Ribeiro, Alexandre Barbosa, Mateus Furquim, Átilla Gallio

Year: 1/2013

Genre: Puzzle, platform

 # Players: Single player

Repository: <https://github.com/fgagamedev/Jack-the-Janitor>

Description[1]**:** Jack, The Janitor is a puzzle game where the player controls Jack, a school's janitor who must organize the school's warehouse. Jack can push boxes to the left or to the right and jump boxes.

When Jack fills an entire row with boxes, they disappear from the screen and go to a small window on the right side of he screen called the closet.

The closet shows how Jack organized the rows of boxes. When similar boxes are combined in the closet, Jack gets extra points and some power ups (to be implemented).

The game ends if a falling box hits Jack or if the closet gets full.

B.2 Emperor vs Aliens

Authors: Leonn Ferreira, Luis Gustavo

Year: 2/2012

Genre: Tower defense

 # Players: Single player

Repository: <https://github.com/fgagamedev/Emperor-vs-Aliens>

[1] Available on the repository README.md

B.3 Ninja Siege

Authors: Tiago Gomes Pereira, Matheus Fonseca, Charles Oliveira, Pedro Zanini

Year: 2/2012

Genre: Tower defense

 # Players: Single player

Repository: <https://github.com/fgagamedev/Ninja-Siege>

Description: The ninja academy is being raided and you have to defend it.

B.4 Space Monkeys

Authors: Victor Cotrim

Year: 2/2012

Genre: Tower defense

 # Players: Single player

Repository: <https://github.com/fgagamedev/Space-Monkeys>

Description: Monkeys are attacking your home planet. They come in waves and you have to get rid of them all.

Remarks: It's interest to notice that, by this time, the students of *Introdução aos Jogos Eletrônicos* didn't have designers with them in the team. Figure 10 shows that, given the complexity of developing a game, sometimes the artwork was not a priority. This is also one of the games that didn't run properly after the compilation.

B.5 War of the Nets

Authors: Matheus Faira, Lucas Kanashiro, Luciano Prestes, Lucas Moura

Year: 2/2013

Genre: Turn Based Strategy

 # Players: Multiplayer on LAN

Repository: <https://github.com/fgagamedev/War-of-the-Nets>

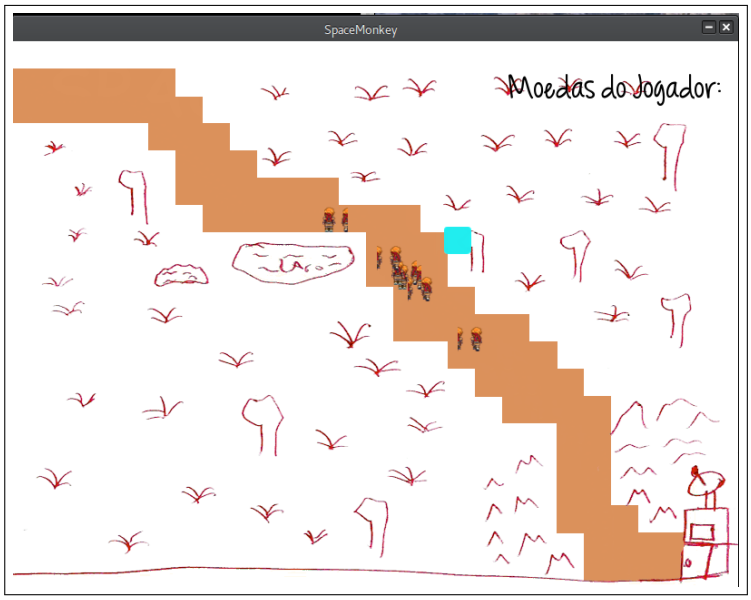

Figure 10 – Space Monkey

Description: It is a turn based strategy (TBS), where the objective is to construct a network from the base to a right point, faster than your enemy. You also can destroy his network with bombs, or infiltrate it with spies.

B.6 Post War

Authors: Bruno de Andrade, Jonathan Rufino, Yago Regis

Year: 2/2013

Genre: Turn Based Strategy

 # Players: Multiplayer on LAN

Repository: <https://github.com/fgagamedev/Post-War>

B.7 Ankhnowledge

Authors: Arthur del Esposte, Alex Campelo, Atilla Gallio

Year: 2/2013

Genre: Turn Based Strategy

 # Players: Multiplayer on LAN

Repository: <https://github.com/fgagamedev/Ankhnowledge>

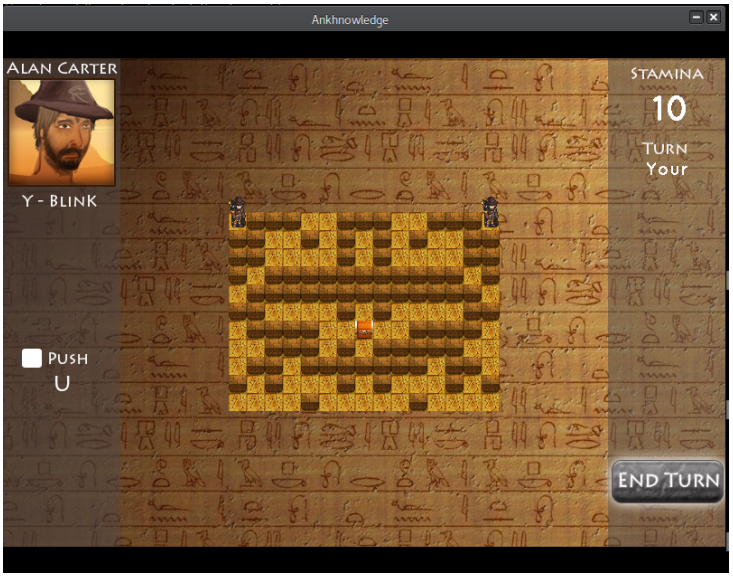

Figure 11 – Ankhnowledge

Remarks: From the games developed before the time the course was taught in conjunction with the students from *Darcy Ribeiro*, this is one of the prettiest and most pleasant games to play. Because one of the students is a software developer and designer, the user interface was very well drawn as seen in Figure 11.

B.8 Last World War

Authors: Gabriela Navarro

Year: 2/2013

Genre: Turn Based Strategy

 # Players: Multiplayer on LAN

Repository: <https://github.com/fgagamedev/LastWorlWar>

B.9 Kays against the World

Authors: Carlos Coelho, Bruno de Amorim Campos, Bruno Carbonell, Guilherme Fenterseifer, Fernando Tollendal, Lucas Sanginez, Victor Bednarczuk

Year: 1/2014

Genre: Platform

 # Players:

Repository: <https://github.com/fgagamedev/Kays-Against-the-World>

B.10 Imagina na Copa

Authors: Iago Mendes Leite, Jonathan Henrique Maia de Moraes, Luciano Henrique Nunes de Almeida, Inara Régia Cardoso, Renata Rinaldi, Lucian Lorens Ramos

Year: 1/2014

Genre: Platform

 # Players: Single player

Repository: <https://github.com/fgagamedev/Imagina-na-Copa>

B.11 Dauphine

Authors: Caio Nardelli, Simiao Carvalho

Year: 1/2014

Genre: Platform

 # Players: Single player

Description: A platforming/stealth game in a medieval fantasy setting, developed with SDL2.

Repository: <https://github.com/fgagamedev/Dauphine>

B.12 Terracota

Authors: Álvaro Fernando, Macartur Sousa, Carlos Oliveira, André Coelho, Pedro Braga, Wendy Abreu, José de Abreu

Year: 1/2015

Genre: Adventure

 # Players: Single player

Repository: <https://github.com/fgagamedev/Terracota>

B.13 7 Keys

Authors: Paulo Markes, Bruno Contessotto Bragança Pinheiro, Lucas Rufino, Luis André Leal de Holanda Cavalcanti, Maria Cristina Monteiro de Oliveira, Guilherme Henrique Nunes Lopes

Year: 1/2015

Genre: Adventure

 # Players: Single player

Repository: <https://github.com/fgagamedev/7-Keys>

B.14 Babel

Authors: Álex Silva Mesquita, Jefferson Nunes de Sousa Xavier, Rodrigo Gonçalves, Vinícius Corrêa de Almeida, Heitor Campos, Max Von Behr, Aleph Telles de Andrade Casara, Washington Rayk

Year: 1/2015

Genre: Adventure

 # Players: Single player

Repository: <https://github.com/fgagamedev/Babel>

Description: The mankind wanders the universe looking for a new habitable planet. They found an unknown planet with a big and strange tower.

The challenge is explore the tower and the planet and expand your resources, but be careful with the mysteries of this new planet.

B.15 Strife of Mithology

Authors: Jônnatas Lennon Lima Costa, Marcelo Martins de Oliveira, Victor Henrique Magalhães Fernandes, Dylan Jefferson M. Guimarães Guedes

Year: 1/2016

Genre: Tower Defense

 # Players: Single player

Repository: <https://github.com/fgagamedev/Strife-of-Mithology>

Description: A 2d-isometric Tower Defense based on mythology.

B.16 Traveling Will

Authors: João Araújo, Vitor Araujo, Igor Ribeiro Duarte, João Paulo Busche da Cruz

Year: 1/2016

Genre: Platform, Runner

 # Players: Single player

Repository: <https://github.com/fgagamedev/Traveling-Will>

Description: This game tells the story of Will, personification of the Will, trying to restore

Remarks: This game has one of the most attractive user interfaces from the games packaged so far. The team that developed it was able to create a very good game, technically speaking, with engaging scenarios and soundtrack, because they had design and music students. A screen of the game running after compiling it with the building script is shown in Figure 12.

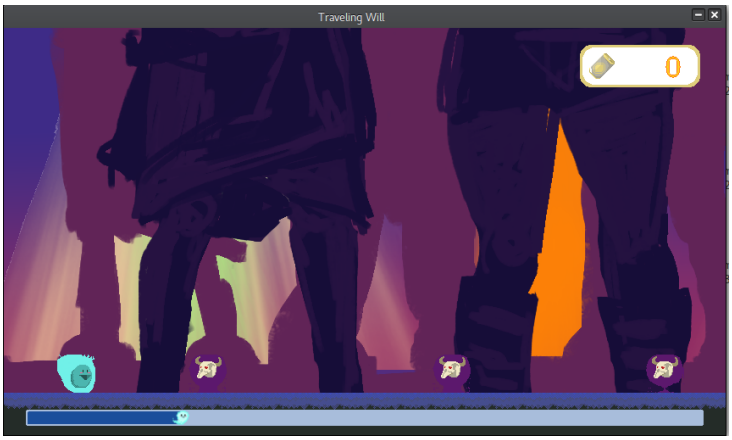

Figure 12 – Traveling Will

B.17 Deadly Wish

Authors: Lucas Mattioli, Victor Arnaud, Vitor Nere, Iago Rodrigues

Year: 1/2016

Genre: Battle Arena

 # Players: Single player

Repository: <https://github.com/fgagamedev/Deadly-Wish>