Lab 1 - PolyMorpher Product Description

Daniel Dang

Old Dominion University

CS411W

Professor Thomas Kennedy

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Author Note

Daniel Dang, Department of Computer Science, Old Dominion University.

This research was done under the supervision and guidance of Thomas Kennedy.

Correspondence concerning this article should be addressed to Daniel Dang, Department of

Computer Science, Old Dominion University, Norfolk, VA 23529.

Contact: ddang003@odu.edu

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1 Introduction

Computer science students at Old Dominion University have a difficult time transitioning from procedural programming to object oriented programming. Team Silver will introduce a solution to the declining retention rates in the computer science department at Old Dominion University by developing a gaming solution to help students learn the fundamental of computer programming and object oriented programming concepts.

1.1 Team Members

Under the guidance of mentor Thomas Kennedy, Team Silver was formed to design and develop PolyMorpher. The members and roles of Team Silver are as follows: Matthew Tuckson (Project Manager and Team Lead), Casey Batten (Team Lead), Daniel Dang (Team Member), Nathaniel Dearce (Team Member), Colten Everitt (Web Designer and Team Member), Tyler Johnson (Team Member), Peter Riley (Team Member), Kevin Santos (Team Member), and Joel Stokes (Team Lead).

1.2 Problem Statement

"Programming is intimidating for the uninitiated. As a result, first time ODU programming students drop out or switch majors. Existing tools fail to teach OOP concepts and problem solving skills" (Team Silver, 2017, 8). Object oriented programming taught in lecture help students understand at a conceptual level but can fail to show real world functionality. A game designed to visually demonstrate OOP concepts can help students grasp a better understanding of fundamentals taught in classes.

1.3 Problem Characteristics

Object Oriented Programing is an organizational method for designing logical programming applications. ODU students are typically are not taught OOP concepts during entry level courses.
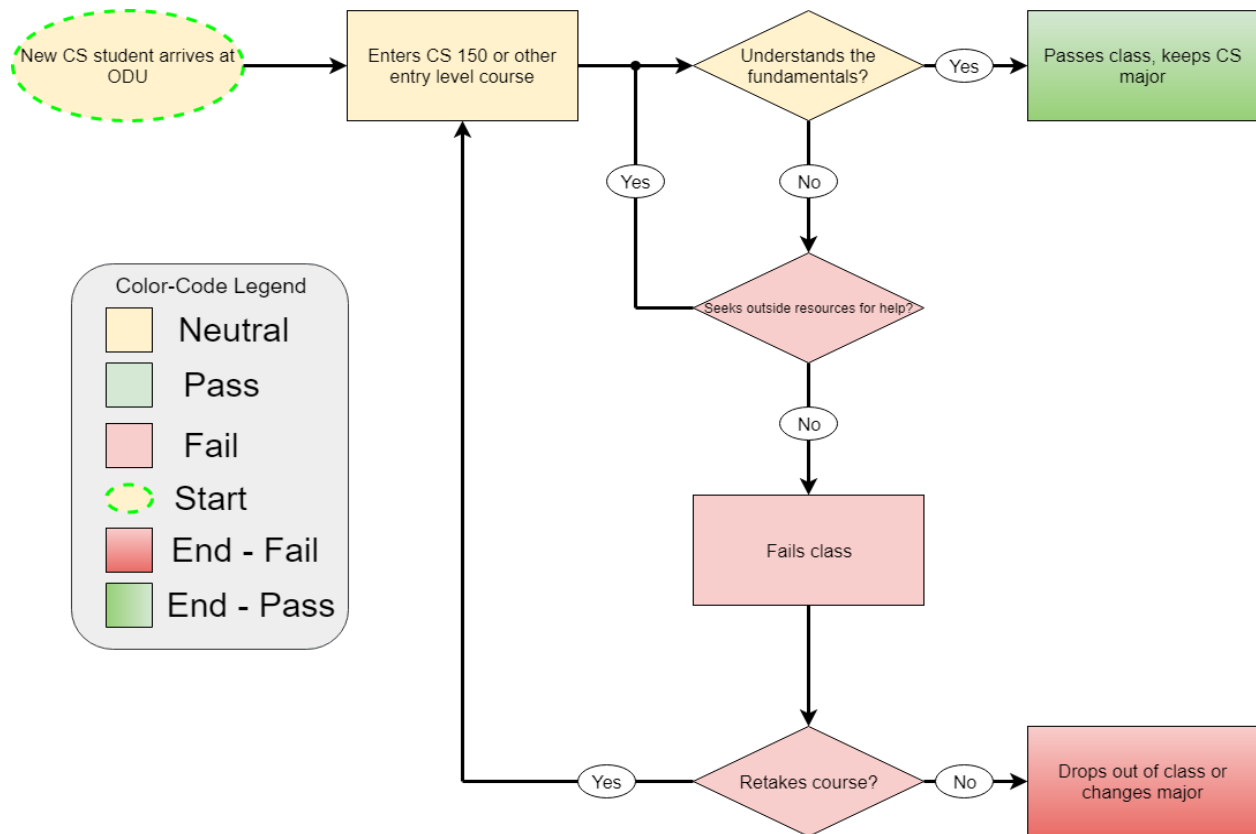
Figure 1: Current Process Flow (Team Silver, 2017)

The conceptual nature of OOP can lead students to have difficulty understanding the fundamentals, thus causing them to fall behind, drop out of classes, or even change majors.

Figure 1 displays the current process flow of an entry level computer science student at ODU. The diagram starts with new students taking CS 150, an introductory computer science course. During the introductory period, students are taught the fundamentals of programming. If the fundamentals are understood by the student, they can pass the class successfully. If the student does not understand the fundamentals, then they may seek help from outside resources, but if it does not help, they will eventually fail the course. They do have the option of retaking

the course, but unless the student is able to grasp the fundamental concepts of programming they

may eventually drop the class or even change majors. This is the problem Team Silver believes

can be solved by introducing additional support to students who have difficulty understanding

the fundaments.

1.4 Solution Characteristics

PolyMorpher, a game developed by Team Silver, aims to address OOP concepts and

problem solving through the use of a Management Simulator and a Tangible User Interface

(TUI). A management simulator can bring experimental sandbox experiences to students who
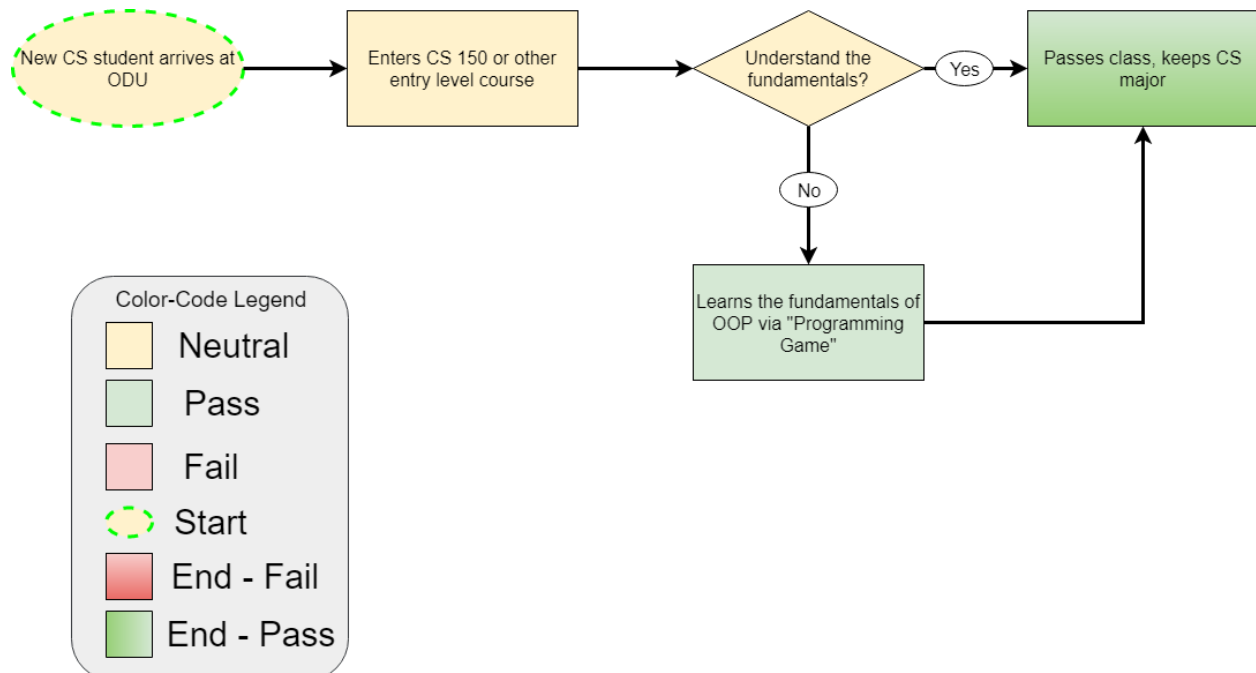
Figure 2: Solution Process Flow (Team Silver, 2017)

want to learn about complex processes. This type of engagement can have a larger impact on

students than a traditional lecture setting. Seeing immediate tangible effects or consequences on

simulated exercises can give students more confidence to experiment and learn.

According to the Office of Naval Research (ONR), an average of 56 to 95 percent of

people who play a particular game to learn a certain subject through test demonstrated a better

understanding of that subject (Team Silver, 2017). Educational games can give students an

incentive to think outside their normal domain of thought. Traditional methods of teaching OOP

concepts are more conceptual and make it difficult for students to fully utilize. PolyMorpher will

introduce interactive puzzles that will be aimed to teach the fundamentals of computer

programming as a supplemental tool to strengthen the concepts taught in a traditional classroom.

Team Silver's solution, as shown in Figure 2, plans to greatly reduce or eliminate the

possibility for students to fail and retake the course. If the student fails to understand the basic

fundamentals taught in class, PolyMorpher aims to be a supplemental solution for students to

solidify the fundamentals needed in order to pass the class and continue with the computer

science curriculum.

1.5 Current Solutions (Competition)

In today's market, many programming games do not teach OOP concepts to the players.

There is not a middle ground between basic games teaching syntax to fully fledged programming

logic games. PolyMorpher bridges the gap between basic syntax level programming to logic

intensive programming architectures. Table 1 and 2 displays the various features provided by

current programming games in comparison with PolyMorpher. Team Silver fills a niche in the

market by targeting users with low to medium experience, teaches OOP concepts, and uses OOP

for core gameplay.

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Table 1: Competition Matrix - Part 1 (Team Silver, 2017)

Game	Experience	Uses OOP	Teaches OOP	# Languages	Multiplayer
PolyMorpher	Low-Mid	Yes	Yes	1	No
Code Combat	Low	Yes	No	5	No
Screeps	Mid-High	Yes	No	1	Yes
CheckIO	Low-High	Yes	No	1	Yes
Code Monkey	Low	No	No	1	No
Elevator Saga	Mid-High	Yes	No	1	No
Codewars	Mid-High	Yes	Yes	6	Yes
Codingame	Low-High	Yes	No	25+	Yes

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Table 2: Competition Matrix - Part 2 (Team Silver, 2017)

Game	Experience	Uses OOP	Teaches OOP	# Languages	Multiplayer
PolyMorpher	Low-Mid	Yes	Yes	1	No
Git Games	Low	No	No	1	No
CSS Diner	Low	No	No	1	No
Flexbox Defense	Low-Mid	No	No	1	No
Ruby Warrior	Low	No	No	1	No
Untrusted	Mid-High	No	No	1	No
Empire of Code	Low-Mid	Yes	No	2	Yes
Ruby Quiz	Mid-High	Yes	No	1	No

As shown from Table 1 and Table 2, PolyMorpher fills the gap between low to middle experiences and helps builds the fundamentals to understand advanced concepts. Currently there is only one language and no multiplayer, this allows PolyMorpher to cater towards a specific language and allows the user to figure out solutions on their own accord. The competitive advantage PolyMorpher has is that it is an application that allows users fully learn the fundamentals of computer science and software development. In addition, the game will teach OOP concepts, key programming and problem solving skills, and engaging single player gameplay.

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2 Product Description

PolyMorpher will be a game where players must learn basic concepts and then apply them in game to win. There will be tutorials followed challenges for the players to solve. Players must code their own path the solution.

2.1 Goals and Objectives

PolyMorpher aims to provide a unique learning experience for new programmers who want to learn a skill through interactive learning puzzles. The main objective is to teach core OOP design concepts such as; abstraction, inheritance, polymorphism, and encapsulation. The game will help users develop problem solving skills while providing a fun gaming experience.

2.2 Key Product Features and Capabilities

Important core gameplay features of PolyMorpher include using a realistic approach, supplement concepts taught in class, and balance fun gameplay with intensive gameplay. In order to help players better understand the fundamentals of programming, relatable examples help users solve problems on their own accord. More complex Object-Oriented Programming concepts can be more easily explained through visual interactive demonstrations rather than tradition audio and textual resources. By having a focus on balance of gameplay and player experience, PolyMorpher aims to achieve balance between engagement and learning.

2.2.1 Minimal Game Specifications

PolyMorpher will be optimized for machines with 4th geneartion i3 Intel Processors. The minimal operating system required to run PolyMorpher will be Windows 7. PolyMorpher will be a 2D game requiring minimal processing power. Additional graphics processing power will provide users a smoother gaming experience.

2.2.2 Obtaining PolyMorpher

Customers can obtain PolyMorpher by going to Team Silver's website,

http://www.cs.odu.edu/~411silver/, and downloaded the appropriate game file under the

downloads tab.

3 Identification of Case Study

PolyMorpher was introduced to solve student progression issues within the ODU

computer science department. Although it is a solution designed for computer science students,

PolyMorpher is accessible towards general audiences outside of the classroom as well. It was

created in order to ease programming concepts to new students in an intuitive way.

3.1 End User

End users of PolyMorpher will include students, teachers, and people who want a

supplemental resource for learning object oriented programming.

3.1.1 University Students

Although PolyMorpher is designed for all students, the original goal is intended to

provide a supplimental resource to ODU students who are struggling with CS 150 and above.

Although it was designed with these specific students in mind, PolyMorpher could fill the niche

for students from other Universities as well.

3.1.2 Instructors

Individual instructors can utilize the game in classrooms to give students additional

examples of certain concepts.

**3.1.3 Self Learning Programming Students**

Targeting self-studying programming who are not programming from traditional

institutions can help give real world interactive examples to otherwise conceptual topics.

3.2 Target Customers: Old Dominion University

PolyMorpher intends to help Old Dominion University computer science students excel in the beginner to intermediate programming classes. Increasing student retention in the program will help student engagement, prestige, and revenue of the department. Ultimately PolyMorpher core consumer target includes anyone who is seeking to understand the fundamentals of computer programming, OOP concepts, and improve problem solving skills.

3.3 Why PolyMorpher?

	CS 150	CS 250	CS 361	CS 330	CS 350
2013-2014	804	327	161	111	93
2014-2015	672	367	208	203	148
2015-2016	937	327	217	195	183
2016-2017	920	337	199	180	182
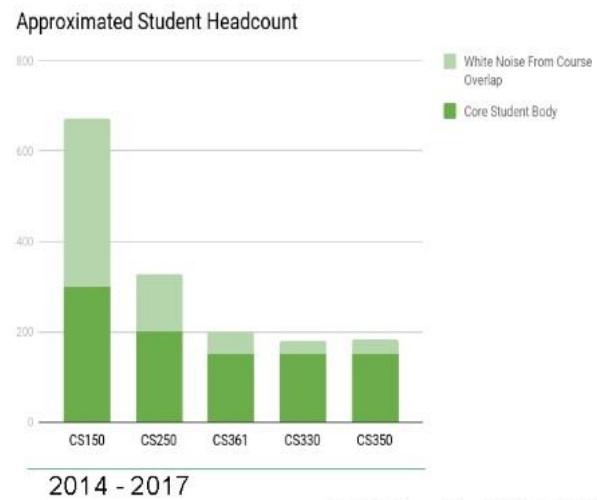
Figure 3: Student Enrollment Statistics

Currently there is a student progression dilemma for computer science students at ODU. Recent statistics provided by Team Silver's advisor, Thomas Kennedy, shows a decreasing number of students progressing to upper computer science classes. Although a portion of students from lower level programming classes are not computer science majors, there is still a disproportionate amount of students in higher level computer science classes compared to lower level classes. PolyMorpher can help increase student retention as they progress through the computer science degree program.

Figure 3 contains the number of students enrolled in the four main programming course within the last 4 years. The drop in progression from CS 150 to CS 250 can be attributed to the fact that CS 150 is a requirement for non-computer science majors. Students enrolling in CS 250 can be largely attributed to computer science, computer engineering, and modeling and simulation majors. There is still a large gap in retention with only computer science students.

4 PolyMorpher Prototype Description

A prototype of PolyMorpher will be released early in Q2 of 2018. The prototype will be in beta testing for initial user feedback. It will not likely contain a fully working product but will be functional enough to meet the core objectives and purpose of the game.

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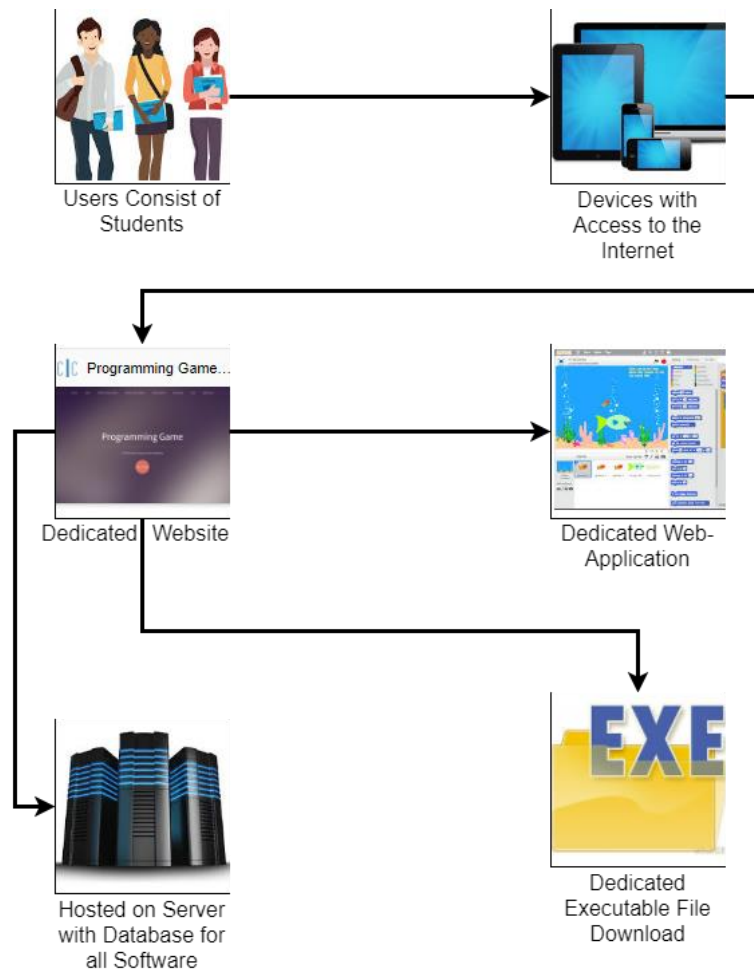
4.1 PolyMorpher Architecture

Figure 4: PolyMorpher Architecture

Figure 4 above shows the core architecture implementation of the PolyMorpher. The final

version of the game will be a downloaded able executed file found on the dedicated CS 411

website. Although futures plans can be made to implement a dedicated web application, an initial

prototype will not include one. A server and database will not be included in the initial prototype

but will be needed in case of including player scores and multiplayer implementations.

4.2 Functional Prototype Features and Capabilities

In order to maintain within the scope of the core goal and objective, PolyMorpher will ship with key programming concepts needed to succeed ODU's object oriented programming class.

4.2.1 PolyMorpher Function Features

The main object of PolyMorpher is to give students a supplemental resource when learning OOP. Programming levels will include a lesson and a corresponding puzzle of the following OOP principles:

- Abstraction

- Inheritance

- Encapsulation

- Polymorphism

Lessons will be taught through interactive puzzles. Players must apply what they have learned to the challenges in order to progress through the game. Lessons on each of the key concepts above will be given and corresponding puzzles will be natively created to help players build a solid foundation while progressing through the game. As the game levels progress, game challenges will become more difficult and players must apply previously learned programming and game knowledge to progress. An initial tutorial will be included to show the basic game mechanics of the game, controls, and preliminary programming fundamentals in order to successfully progress.

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Elements	Description	Real World Product	Prototype
Teaches Polymorphism	Provision of a single interface to entities of different types		
Teaches Abstraction	Technique for arranging complexity of systems		
Teaches Encapsulation	Building of data with the methods that operate on that data		
Teaches Inheritance	When an object or class is based on another object or class, using the same implementation		
Single Language Taught	A single programming language will be focused on C#.		
Single Player	Focused on an experience targeted to interact with only one player		
Downloadable .EXE File	Desktop application version of the game		
Game Assets	Primary components that are used as building block to construct the more complex features and levels of the game		
Developed Story	Narrative used to drive progression or direct player throughout a more guided/linear experience		
Portable Compiler	Code compiler used to run player-made code on the fly in game		
Tutorial Section	Precursor series of levels meant to help the player adjust to the in-game toolset given to them and also prep them with knowledge of the language(s) they will be working with		
Player-Made Content	Variant of Sandbox Level, potentially allows the player to share custom levels with one another		
Sandbox Level	Open level where the player has access to all tools at once and can build their own level sequences and puzzles		
Multiple Languages	Alternative programming languages for the player to use and learn in-game		
Multiple Player	An experience geared toward multiple players interacting with a game environment together		
Web Application	Web based version of the game running in-browser		
Multiple Languages Taught	Alternative programming languages for the player to use and learn in-game		

Table 3: Prototype Features (Team Silver, 2017)

Figure 5: Prototype
Features Key

Table 3 and key show the core features will and will not be implemented in PolyMorpher. The core feature of PoloyMorpher will include a fully function C# portable compiler that can compile code written by the player within the game. This feature will allow players to apply what they have learned in game without even leaving the game itself. The prototype will allow users to test and debug their code in order to find a working solution to solve the puzzle. This will initially be a single player experience. An interactive story will give a seamless user experience and transition players between the various game puzzles.

4.3 Algorithms

PolyMorpher needs three algorithms in order to meet the aforementioned objectives. These three algorithms allow the player to change the properties of selected objects within the game.

4.3.1 Core Algorithm

The core algorithm will consist of steps a player will need to go through to manipulate an in game object. This algorithm allows the player to choose and manipulate in game objects need to solve the puzzle. The algorithm starts when a player chooses the morph button in game. The

morph feature will allow the player to choose which object they want to morph. The morphing

option will range from predetermined game objects to player chosen game objects. A morphable

item is an item that players can attach a script to the object. Players will need to write the script

on their own to morph the object and complete the puzzle. After selecting a morphable object,

the player will be taken to an in game programming environment with a text box with Start() and

Update() buttons. Depending on the action the player chooses to take, different algorithms will
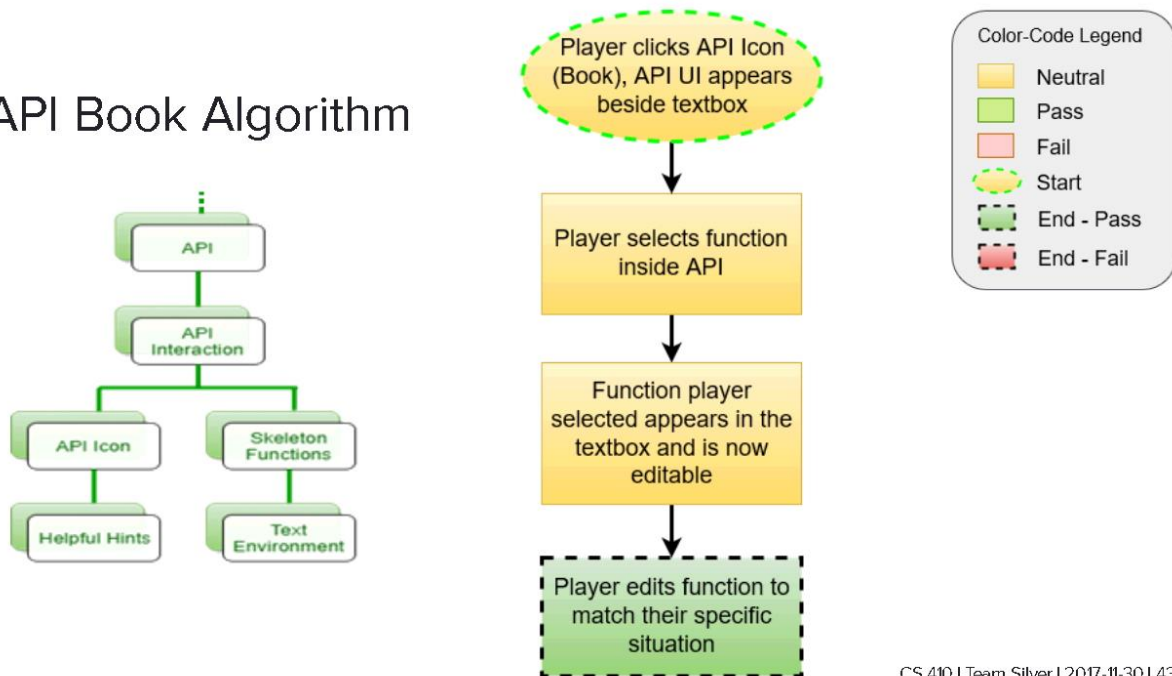
Figure 6: API Book Algorithm

initiate. If they player chooses to enter the API book algorithm shown in Figure 6 below, a book

will appear and players can select predetermined scripts to apply to the selected object. Once a

selected script is applied, the player will need to press the compile button to check for coding

errors. If there are errors, then the player will be sent back to the text editor to fix the errors. If

there are no errors, then a success icon will appear the object will attain the input desired.

4.3.2 Compiler Algorithm

The compiler algorithm in Figure 7 below is needed for the player to have their code actually run during compilation runtime. The compiler algorithm below will allow the player to run the code they have entered during the API book algorithm.
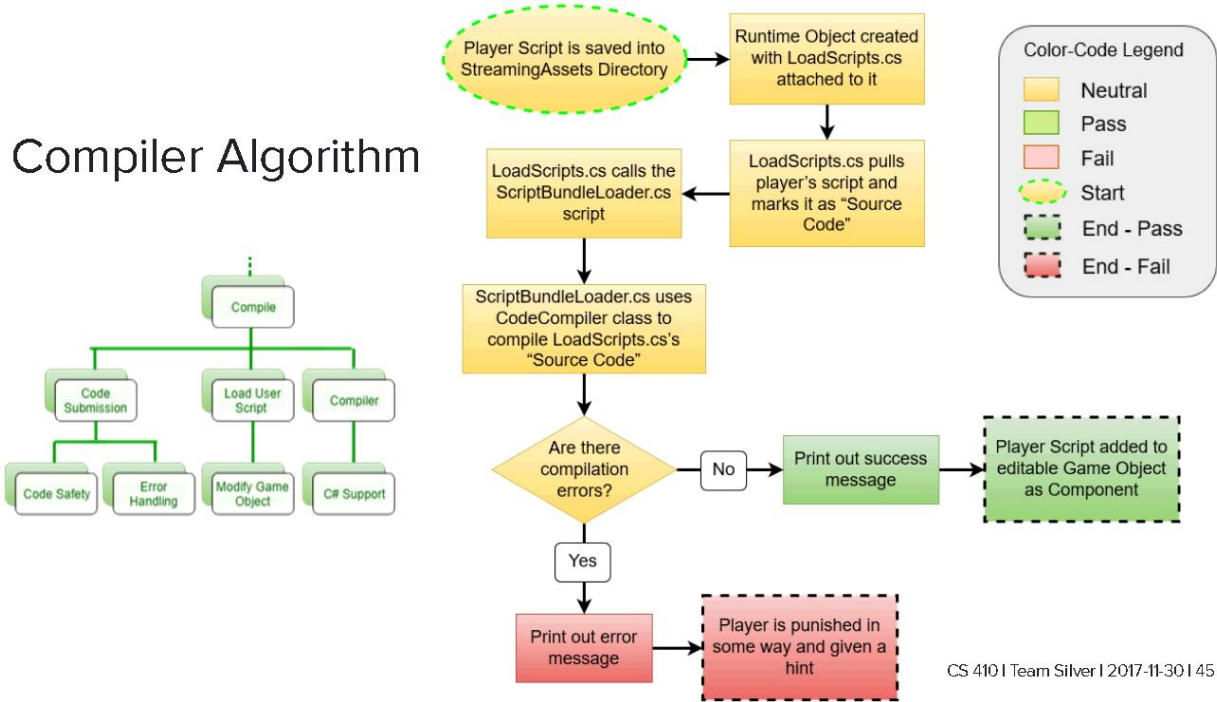

Figure 7: Compiler Algorithm

4.4 Prototype Development Risks and Mitigation

There is some inherent risk in the development of PolyMorpher. One of the biggest risk in implementing PolyMorpher is the user entering malfunctioning code. It would be very difficult for the development team to test for every single situation in which malicious code can be used to break the game. Team Silver will test for the most likely scenarios and try to mitigate the possibility of code malfunction. Another high priority risk that there will not be enough material provided to support the API. The object of the game is to teach OOP concepts so if the game does not sufficient player support then the player is going to be dissatisfied and quit the game. Team Silver will focus mainly on these two risk and apply the appropriate mitigation in order to keep players satisfied and engage in the end product
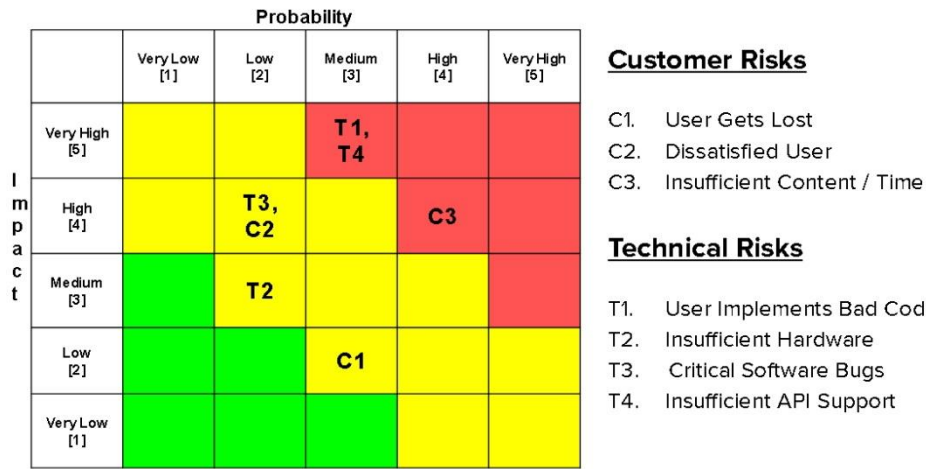
Figure 9: Risk Matrix
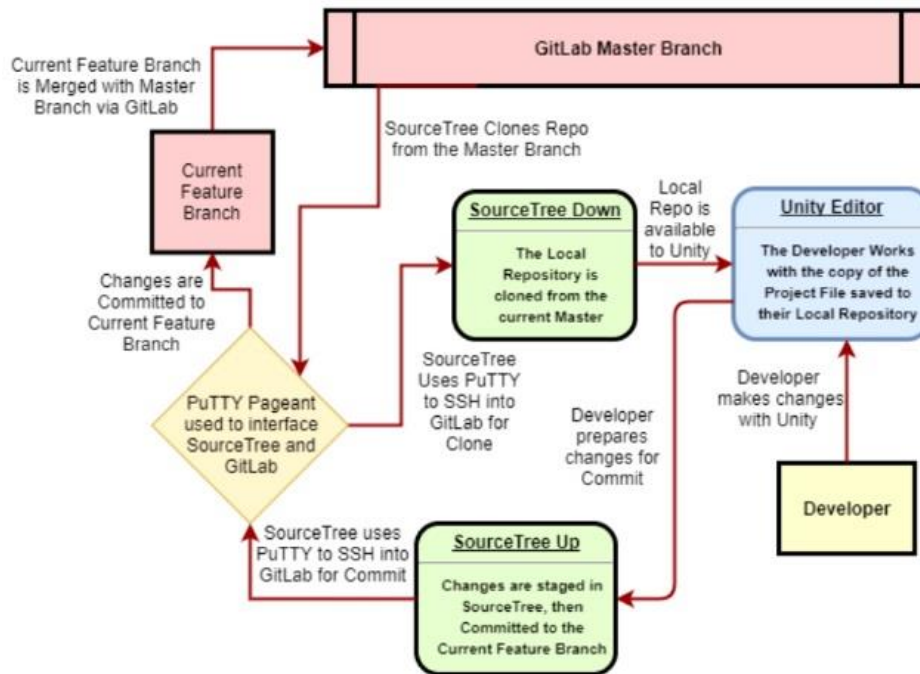
5. Development Pipeline

Figure 8: Development Pipeline

The core game development will be done on the Unity Software Develop Kit (SDK). Unity's SDK has a built in IDE called MonoDevelop which will be used by Team Silver to develop the overall game. Code will be stored on GitLab as the main version control mechanism. To interact with the Unity SDK and GitLab, SourceTree will act as a local intermediary between the GitLap and Unity. SourceTree allows individual developers to push to the development repositories on GitLab.

5.1 Agile Development

Team Silver will employ the agile development process to deploy individual features. Developers will work in sprints to plan, develop, test, and deploy new features. A demo application will be approved by the group and then pushed into the master branch of the game. After a successful push, team leads will determine the next development aspect the game and continue with the new sprint. The process iterates until the core gameplay has been developed.

5.2 Work Management

There are currently nine developers developing PolyMorpher. The nine members have been split into three separate teams, with three members in each team. Within the sub-team there is a team leader who keeps their sub team on track with development goes throughout the sprint. The sub team leaders report to the project manager during the weekly stand up meetings. This method of team division will evenly distribute development work to everyone and not allow team members to feel overwhelmed or stuck. Having sub teams will also allow rapid development and testing within teams. Using sub team and version control allows individual developers to be efficient and not allow single issues to block development.

6. Glossary

API: Application Program Interface

Git: version control system for tracking changes in computer files and coordinating work on

those files among multiple people.

GitLab: web-based git repository manager the includes wiki and issue tracking.

Gradle: an open-source build automation system that was designed for multi-project builds.

GUI: Graphical User Interface

JavaScript: a programming language commonly used in web development where the the code is

processed by the client's browser.

MySQL: an open source multi-user database management system.

Non-Technical Game: user-friendly gameplay able to be utilized by non-technical users.

Non-Technical User: user who lacks formal education or knowledge in computer science,

computer programming, object-oriented programming, or problem solving skills.

ODU: Abbreviation for Old Dominion University.

Platform: an integrated set of packaged and custom applications tied together with middleware.

Regression Testing: a type of application testing that determines if modifications to the

application have altered the application negatively.

Student Involvement: the amount of physical energy students exert and the amount of

psychological energy they put into their college experience.

TUI: Tangible User Interface

Ubuntu: open-source Linux operating system.

User-Friendly: easy to comprehend by non-technical users.

Virtual Machines: an emulation of a computer system that provide functionality of a physical

      computer.

Web Application: a client-server computer program in which the client (including the user

      interface and client-side logic) runs in a web browser.

Wiki: a website on which users collaboratively modify content and structure directly from the

      web browser.

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