Design Document

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1. Executive Summary

Commander was born from the frustrations we experienced with traditional scripting environments, especially those relating to command line automation. Common command line scripting environments include Bash and Powershell. While great for their direct connection to the command line and using/parsing command outputs, they also have a limited set of actions the user may perform and unintuitive syntax. As for Bash, the language is not strongly typed which makes things confusing for programmers coming from a more structured language, and makes tasks such as doing math more involved due to having to parse strings. In comparison, programming languages targeted toward a general audience like Python and Perl are powerful with better syntax and typing, but lack the simple directness of a command line scripting environment and easy parsing of output from commands.

The first of many differences with Commander compared to its contemporaries is the language's syntax. The goal of Commander is to be a simple language with an interpreter, like Python, but include additional syntax for user clarity. Much of the syntax takes inspiration from C and its derivative languages like C#, Java, and Javascript since these languages are pretty familiar to most programmers, thus allowing for a less steep learning curve for people new to Commander. Commander allows users to quickly develop scripts for their projects while maintaining readable code. Moreover, language interpreters such as Python's are notorious in certain groups for a variety of reasons, often low performance. The Commander interpreter is written in C++ for faster interpretation and execution time.

Similarly, scripting environments are primarily exclusive to a specific platform. Powershell, for instance, is included on Windows by default as the go-to scripting environment. While it is possible to install and run Powershell on Linux, one must go through the process of installation, and even once installed will still have to use Bash to utilize certain dependencies tied exclusively to it. One benefit of Commander compared to other environments is its ability to be run on multiple platforms, including Windows, macOS, and Linux, via the multi-platform interpreter and run commands independent of the primary scripting environment. Additionally, no additional dependencies will be required to run the interpreter using the pre-built executables that will be released for each version of Commander on the GitLab page. Upon completion, the project will also be released as open-source under the MIT license, allowing other users to compile the application on their machines or make contributions as they feel inclined. If time permits, we will also create plugins for various text editors and IDEs in order to provide nice features including syntax highlighting for the Commander language. The result is ultimately an environment that can be built and run anywhere the user would like with the tools needed to easily program their Commander scripts.

Our goal for Commander is to provide a scripting environment which resolves the aforementioned problems that present implementations have. Users will want to use Commander due to its accessibility and ease along with the benefits of a traditional programming language. It is our hope that Commander will enable veterans and new command-line users to develop the command line scripts that they desire.

2. Background and Technical Requirements

a. Similar Languages

Projects similar to ours include *AngelScript*, *Bash*, *Batsh*, *Lua*, *Perl*, *PowerShell*, and *Python*. A brief overview of each of these languages is provided below.

Most of the languages we have observed attempt to provide general purpose features rather than emphasize command execution. Meanwhile, the other scripting languages for command-line programs tend to have unintuitive syntax with a steep learning curve. In the case of Batsh, the creators only provide a transpiler, which translates Batsh into Bash and Windows Batch scripts, so the code cannot be directly executed across multiple operating systems as it can with an interpreter. The goal of Commander is to be a scripting-first language that users will find simple to understand, while offering a speedy interpreter that will be able to execute commands across the three main operating systems: Windows, MacOS, and Linux. A summary of the languages we have observed are as follows:

AngelScript: A flexible scripting library designed to be functional through external scripts. It was designed to be easier for both application and script writers. It implements types like C++ and has similar syntax. A caveat we have identified is AngelScript's usage in game development. In other words, the language is designed with a specific use case in mind.

Bash: Most commonly used in Linux systems, Bash is the GNU Project's shell (*B*ourne *A*gain *SH*ell). It encompasses both a shell environment and a scripting language that allows for users to automate their daily tasks through the shell. Its steep learning curve and confusing syntax may result in unreadable script files. Additionally, it is weakly typed, which makes certain things like math operations more difficult to program.

Batsh: A command-line scripting language with C-like syntax which transpiles (i.e. translates), to either Bash or Windows Batch. There exists an online tool provided by the creators as well which allows you to write a Batsh script and it will output the resulting

Bash/Batch translation. However, it lacks an interpreter or other methods for directly executing the code.

Lua: A scripting language that supports object-oriented programming, functional programming, data-driven programming, and data description. It is used in a wide range of applications like games, web, and image processing. Similarly to Python, Lua is often used as a general-purpose programming language. The language's interaction with the command line for any given operating system is unrefined.

Perl: A general-purpose interpreted scripting language. Its own philosophy is to enable developers to quickly create and test their code. Like most general-purpose scripting languages, interaction with the command line may be indirect or discouraged.

PowerShell: A modern shell-scripting language developed by Microsoft. It is similar to Bash in many respects, and shares some of the same drawbacks. In short, it can directly execute commands well, but its syntax is verbose and not very readable, and it is primarily limited to Windows. (It can run on other platforms, but has some compatibility issues and many dependencies.) One of PowerShell's benefits over Bash is that it is strongly typed, which makes it easier to avoid bugs and do certain things like math.

Python: A general purpose programming language with high emphasis on code readability. The language is very general-purpose, though, and lacks the directness for automating the command line (that is, it takes a lot of code just to run a single command). Other criticisms include its generally slower performance compared to other languages and its used of indentation for defining scopes.

b. Required Technology

While we develop Commander, we intend to use the following technologies:

C++: We plan on programming the interpreter in a low-level language, both for direct access to system files and streams and for runtime efficiency. We selected C++ as everyone in our team is familiar with the language.

Unit Testing: We plan on writing extensive unit tests in order to ensure the accuracy of the Commander interpreter. These tests will use the GoogleTest unit testing library for ease-of-use, reproducibility, and reliability.

File I/O and Commands: The interpreter will require access to and utilize the file system on the operating system of choice when it is run. Not only will this be required to

read in and run the script files, but to also find and execute the referenced commands that are stored as executable binaries in the system.

Text Editors/IDEs: We plan on utilizing powerful text editors and IDEs such as Vim, Emacs, VSCode, and CLion in order to program the interpreter. These editors often provide many tools and plugins such as Intellisense, syntax highlighting, and debuggers to help make programming easier and less error-prone. If time permits, we will write plugins for these editors in order to help people programming in Commander to have access to some of these same features.

GitLab/GitHub: We will use GitLab for version control. GitLab has many tools for managing features and goals the project will have. Upon completing CS4500, we will move the repository to GitHub as an open source project for future version control. This choice is due to the sheer number of users working with GitHub, which will allow more developers to have easier access to the project.

c. Software/Hardware Requirements

In order to compile and build the interpreter, a C++ compiler such as gcc or clang is required. However, pre-built executables will be provided, so there are no software requirements or dependencies that clients will need to install. Commander will be multi-platform; that is, it will run on Windows, macOS, and Linux computers. The development focus will be on making it work on x86-64 architectures, but it will likely be portable to ARM or other architectures as well. There are no further anticipated hardware requirements.

3. Requirements Analysis

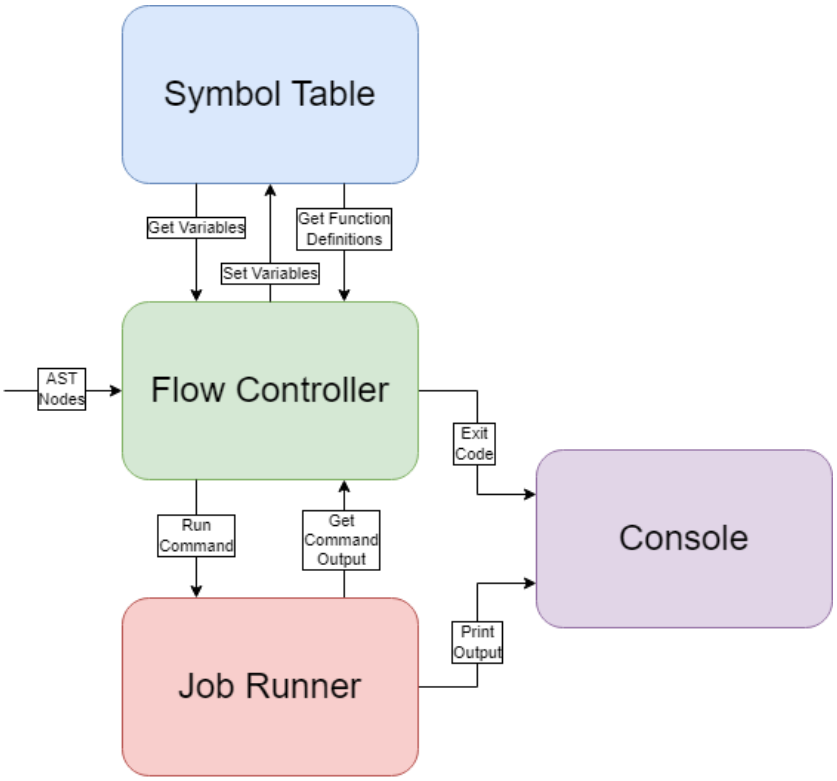
System Architecture

This project will be structured as a series of stages. The output of one stage becomes the input for the next stage, and through a step-by-step process, the script is parsed and then interpreted.

First, the input script file is fed into the lexer as a series of bytes. The bytes are then lexed into *tokens,* which are essentially the individual units of keywords, punctuation, variable names, and numbers. These tokens are fed to the parser. The parser examines these tokens and parses them into *Abstract Syntax Tree Nodes*, which have meaning. These AST nodes form a series of commands, which can be interpreted and run. Before that, the AST nodes are sent to the type-checker, which ensures that expressions are well-formed

and variables are defined before use. The following diagram represents the parsing workflow of the interpreter:

After this workflow is complete, the commands are ready to be interpreted, and each node in the series is executed one by one. The interpreter is composed of a few different pieces. First, the flow controller executes the AST nodes as they are encountered. Things like conditional statements, function calls, and loops will be interpreted by the flow controller, and the location in the series of AST nodes will be updated appropriately. The symbol table tracks the values of variables, and stores the code of functions. The job runner will run commands on the command line, and will manage advanced operations like pipes, input/output redirection, and running sub-processes in the background.



Personnel

The following paragraphs outline the required modules, as well as the team members' responsibilities for seeing these modules to completion:

Formal language specification:

Preston Hales because he has a good eye for detail and since he is familiar with how other language specifications have been written having taken the Compilers class.

Cayden Lund because he is familiar with language specifications, having taken the Compilers class and currently taking the Programming Languages class.

Lexer:

Preston Hales because he has implemented a lexer for the Compilers class in both Java and C++.

Parser:

Cayden Lund because he has implemented a parser for the Compilers class as well as a proof-of-concept LR parser demo.

Type-checker:

Jaden Gill would have the opportunity to learn a new technology with the assigned task.

Symbol table/Garbage Collection:

Jaden Gill this would allow the opportunity to learn a new technology similar to Type-checking.

Flow controller:

Eduardo Valdivia because he has prior experience working with MVC architecture, which this is kind of similar to.

Job runner:

Eduardo Valdivia because of the understanding of processes (piping, redirection, locks, ...) he gained from the Operating System and Computer System courses he took.

Unit testing system:

Preston Hales because he is familiar with writing tests from both the Compilers class and from professional experience.

Eduardo Valdivia because he has experience writing tests all throughout his time as a student.

Syntax Highlighter Plugins (stretch goal):

Preston Hales (VSCode) because he has programmed a lot in the VS Code ide before, and since he has a lot of experience with Javascript professionally, which will be used for implementing the plugin.

Eduardo Valdivia (Notepad++) because he wants to learn a new editor and create a plugin for it.

Cayden Lund (NeoVim/Emacs) because he has worked with NeoVim before, and because Emacs will share much of the same code.

Jaden Gill (CLion/IntelliJ/PyCharm) due to previous experience with CLion, IntelliJ, and PyCharm IDEs.

Transpiler (super stretch goal):

Preston Hales (Powershell) because he uses Windows primarily

Eduardo Valdivia (Batch) because he wants to learn a new environment on Windows.

Cayden Lund (Bash) because of his familiarity with Linux

Jaden Gill (Python) due to previous and extensive experience with the Python language.

Shell (super mega stretch goal):

Cayden Lund because he is familiar with working with the shell and is interested in learning to use PDCurses for tab completion, etc.

System Features

1. **Rank 1: Infrastructure and Core Functionality**
    a. Commander Language Specification
        i. The Commander language will be well-defined, meaning that it will have a formal, flexible, and explicitly-defined grammar that will be LR parseable. The grammar must do all these things; otherwise, it will result in a language that will be difficult if not impossible to parse, will have much ambiguity, and/or make it difficult to add additional language features later down the road.
    b. Interpreter: Basic Implementation
        i. A basic interpreter that is able to lex, parse, type-check, and run basic scripts is all considered core functionality for Commander. Without this, it will be impossible to run any Commander scripts.
2. **Rank 2: Planned Features**
    a. Interpreter: Full Implementation
        i. The interpreter will cover the entire language specification, including advanced features. It will be able to interface with the command line to read files and run commands.

ii. The interpreter will include many helpful error messages whenever it detects a mistake somewhere in the script being executed (e.g. a syntax error).

iii. We plan to have various language features, many of which are mentioned in the use cases (see the appendix). These include the following, as a non-exhaustive list:

1. Direct command execution
2. Advanced command execution
    a. Run a command in the background (i.e., asynchronously)
    b. Run a command whose output can be piped into the input for another command
    c. Run a command and store output (stdout/stderr) into a file
    d. Run a command, taking input from an existing file
    e. Run a command, and utilize the output of that command throughout the script (by storing it into a variable, or using it in some operation/expression)
    f. Run a command, and terminate the command if it takes too long
    g. Run a command and use the exit code
3. Command aliasing
4. Variables
5. Loops
    a. **`while`** loops
    b. **`do`**/**`while`** loops
    c. **`for`** loops
6. **`if`**/**`else`** statements
7. Functions
8. Math operations
    a. Unary: {**`-`**, **`--`**, **`++`**}
    b. Binary: {**`+`**, **`-`**, **`*`**, **`/`**, **`%`**, **`**`**}
    c. Comparison: {**`<`**, **`<=`**, **`==`**, **`!=`**, **`>=`**, **`>`**}
9. Boolean operations
    a. Logic: {**`||`**, **`&&`**, **`!`**}
    b. Comparison: {**`==`**, **`!=`**}
    c. Ternary
10. String concatenation
11. String interpolation
12. Multi-line strings
13. Lambda expressions/functional programming
14. User-defined scopes
15. File I/O

16. User I/O (**`read`** function to read user input, **`print`** function for user output)
17. Comments
18. Libraries (i.e., reuse Commander code from other files)
19. Strong typing, with the option to explicitly specify the types of variables
    a. {**`int`** (64 bit), **`float`** (64 bit), **`bool`** (8 bit), **`string`**, **`function`**, **`tuple`**, **`array`**}
20. Type functions (e.g., **`substring()`** for strings, **`length()`** for arrays)
21. Parsing functions (e.g., **`parseInt("3")`**, **`parseFloat(3)`**)
22. Common math functions (e.g., **`sqrt(4)`**, **`sin(3.141)`**)
23. Time functions (e.g., functions that can get the current time or date of the system)
24. Execution control functions (e.g., **`sleep(10)`**)

b. Documentation
   i. The Commander language will have full documentation. This will describe and discuss all aspects of the language, including expected inputs and outputs, errors, and usage examples.
   ii. The documentation will describe usage of the interpreter, including the flags that can be used, as well as error conditions and how they are handled. The interpreter will also include a **`--help`** flag that will describe its usage when invoked.
   iii. The interpreter's API will also be laid out in the documentation, describing the classes and methods in the code base. This will make it easier for others to understand how the interpreter functions, so that developers can either extend the interpreter or contribute to the project.

3. Rank 3: Advanced Individual Features (Bells and Whistles, Stretch Goals)

a. Syntax Highlighting
   i. We will develop syntax highlighting plugins for various different popular IDEs, including the following:
      1. **Visual Studio Code**. This plugin will be written in JavaScript. Microsoft has excellent plugin documentation.

2. **CLion/IntelliJ/PyCharm**. This plugin will be written in Java, and will work across all these IDEs. Jetbrains has excellent plugin documentation.
3. **NeoVim/Emacs**. This plugin will be written in JavaScript and will integrate with the Treesitter tool, and will then be compatible with both. Treesitter has excellent usage documentation.
4. **Notepad++**. This plugin will be written in C++. This is a lower priority than the other IDEs.
5. **Visual Studio**. This plugin will be written in C#. This is a lower priority than the other IDEs.

b. Shell/Read Evaluate Print Loop
   i. In a REPL environment, the program will read a line of user input, parse and evaluate it, and print the result. The shell is an example of a REPL environment: the user's input instructs the shell to run a command with the given arguments, and then the result is printed to the console. The Python executable also has a REPL environment that can be entered from the console. This stretch goal is to create a REPL environment for the Commander language, where a user will enter a line of Commander code and the program will interpret it. Because of the nature of the Commander language, this REPL environment will essentially function as an alternative shell, with some extra features and functionality.

c. Implement LSP API
   i. This might be a big stretch goal, but implement the LSP API to have cool features (smart renaming, jump to definition, …) integrated in multiple IDEs.

d. Transpiler
   i. Add ability to translate code from Commander to another command line scripting language such as Bash, Powershell, or Batch.
   ii. This would be a feature of the interpreter, but would only run when provided a specific flag, such as **`--bash`** for transpiling to Bash.

Software Engineering Tools and Techniques

1. Our team intends to use Agile for managing the development of Commander. This will allow us to focus on set goals within an allotted time (known as a sprint). At

the end of each sprint, our team can discuss our contributions, evaluate the next steps, and seek help as needed.

2. We intend to utilize several tools while developing Commander. These include the following:
    a. Our team will use the CLion IDE. The environment integrates CMake by default, allowing for quality, reproducible, cross-platform building.
    b. We intend to use the GoogleTest library for testing our project, which will allow us to write comprehensive unit tests for each portion of the project. This will allow us to quickly diagnose issues when changes have been made to our codebase. We do not intend to use other API testing tools outside of unit testing.
    c. We will use GitLab for bug tracking. The suite provides tools for us to manage and track bugs and other issues in the code. For example, we will use GitLab's issue board to display current bugs and time estimates. This will further permit us to assign debugging tasks to each member.
    d. Versioning will further be maintained by GitLab. As previously discussed, however, we will move the repository to GitHub upon completion of the senior capstone courses.

3. Regarding code reviews, we will have all code written in separate branches. When code is ready to be merged into main, a pull request will be created and the user who created the pull request will assign the remaining members as code reviewers. In other words, everyone on the team will need to review code before it gets merged into main. We will use this strategy so that everyone can be familiar with the entire code base, even for parts that they didn't write. In addition to encouraging feedback, this will further provide less error-prone code. If the workload from this system impacts the team negatively, we will reduce the number of reviewers per pull request to either one or two.

4. Our project's documentation will be hosted on GitLab, using GitLab's wiki tools. During the project's development, we'll maintain a language specification sheet containing the programming language grammar and explanations, examples, and anything else that might help with understanding the language.

5. Our team will communicate primarily through Discord. The platform allows us to communicate through text and voice calls, and share links to relevant documents. We use the service's voice call feature to discuss aspects of the project when meeting remotely.

6. Team meetings will be held at 6:00 PM on Mondays, 9:40 AM on Wednesday, 9:40 AM on Friday, and 12:00 PM on Friday. Monday's meeting will be hosted virtually while the remaining times will be held in-person.

4. Timeline

1. **Alpha Phase -** The goal for the Alpha phase is to add in all the language features we have planned so far, ultimately resulting in having a fully functioning interpreter that can run programs with the various features that we have. Most work will likely be on the parser, type checker, job runner, and flow controller, with possible changes to the lexer as needed. Tests will be written as well, but thorough testing will likely be done in the Beta phase.

Week	Cayden Lund	Eduardo Valdivia	Jaden Gill	Preston Hales
1	Begin restructuring the parser to be independent of other tools.	All job related language features done and possibly starting the Flow Controller	Begin garbage collection logic	Work on structuring the documentation, splitting up the language specification, etc.
2	Complete restructuring the parser to be independent of other tools.	Flow Controller start	Finish garbage collection	Do very thorough testing of the Lexer to ensure it is all fleshed out. Refactor, and clean up code as necessary. Start on thoroughly testing the Parser.
3	Implement parsing of extended grammar definitions for additional (non-prototype) language features.	Implement built-ins for the language and discuss with the team of possible redesign of job runner to future proof for a shell.	Polish existing classes (Scope, ScopeOrganizer, TypeChecker)	Finish thoroughly testing the parser, and then thoroughly test the type checker, symbol table, and garbage collection.
4	Write a command-line interface tying the lexer, the parser, and the	Continue work on built-ins.	Create extensive tests for assigned classes	Thoroughly test job runner and flow controller, and other areas that haven't yet

	type-checker together.			been thoroughly tested.

2. **Beta Phase -** The goal for the Beta phase is to ensure correctness of the existing architecture and possibly start on or pitch new individual features we want to add to the project. There will be very thorough testing of all aspects of the project, and debugging everything to make sure things are as polished as we can make them. Additional features will likely be added to the language as well during this phase. If there is more time after these things, we will begin the final phase early since some of the parts of the final phase may take more than 4 weeks to accomplish.

Week	Cayden Lund	Eduardo Valdivia	Jaden Gill	Preston Hales
5	Write extensive parser unit tests.	Write tests for built-ins	Finalize typing conventions and begin planning individual contribution	Finish any thorough testing that hasn't been finished yet, especially on any new features. Update documentation further as needed to ensure that all language features are included.
6	Add the job runner to the command-line interface.	Write tests involving job runners and other areas of the project.	Begin IntelliJ/Pycharm/ Clion plugin development	Begin working on VSCode plugin for syntax highlighting, continuing to write tests or update documentation as needed.
7	Write extensive type-checking unit tests.	Start work on Notepad++ syntax highlighting	Continue with assigned development plugin	Continue working on VSCode plugin, and writing tests and updating documentation as needed.
8	Write documentation on the project's	Continue work on syntax highlighting and	Complete development plugin	Finish VSCode plugin, and any other

	components and classes for future maintainability.	start looking at transpiling.		tests/documentation changes necessary.

3. **Final Phase -** The goal of the final phase is to work on our stretch goals, particularly with syntax highlighting plugins for various IDEs and also transpilers if there is time. If there is still work from the Beta phase that still isn't finished, that will be first priority before working on any of the stretch goals.

Week	Cayden Lund	Eduardo Valdivia	Jaden Gill	Preston Hales
9	Begin working on the NeoVim plugin.	Start working on transpiler (Batch)	Begin working on unique individual feature	Begin working on the Powershell transpiler (or Bash one depending on how things go).
10	Finish working on the NeoVim plugin and adapt it to Emacs.	Continue working on transpiler (Batch)	Continue working on unique feature / finish unique feature	Continue work on transpiler(s)
11	Start working on the shell-like REPL environment.	Finish up anything needed (Job Runner, Flow Controller, unique features,...)	Begin Python transpiler	Finish up transpiler(s), do any extensive testing as needed.
12	Continue working on the shell-like REPL environment.	Finish up anything needed (Job Runner, Flow Controller, unique features,...)	Finish Python transpiler	Wrap up documentation, and any other last minute things that need to be done.

5. Appendix

Use Cases

The tables on the following pages are dedicated to use cases the Commander team has developed. Use cases describe a variety of situations we expect users to encounter in the finished software. These cases do not reflect the total number of situations a user may encounter, rather aim to describe how a situation will be handled.

To organize each use case, a table will be provided with a letter and number. Numbers will determine the category a use case is organized into, while letters serve as individual cases. For instance, section 1 is dedicated to expected inputs. The first section assumes no errors are present in the user's scripts. Alternatively, section 2 provides some insight into documentation and interaction with other software. Section 3 describes stretch goals; features we intend to implement if we have time in CS 4500. Finally, section 4 describes error handling.

Number	**Use Case 1.A.**
Title	**Running Script**
Preparer	Preston Hales
Actor/User	Commander Scripter
User Story	As a Commander Scripter, I want to be able to write a Commander script in a separate file and pass that file into the interpreter to run the script. In doing so, I can rerun the same script multiple times or in other places.
Course of Events	1. Create a file. 2. Write Commander script. 3. Save the file. 4. Run interpreter with file path as an argument.
Exceptions/Alternates	None
Related UI	**See Sketch 1.A.**

Number	**Use Case 1.B.**
Title	**Multiple Scripts and Code Reuse**
Preparer	Preston Hales

Actor/User	Commander Scripter
User Story	As a Commander scripter, I want to be able to write multiple Commander scripts in different files and import the code (i.e., functions and variables) from one script into another to practice code reuse.
Course of Events	1. Create and write multiple scripts in separate files. 2. Write a script file that imports one or more other scripts, which contain functions and variables. 3. Proceed to use those functions and variables in the current file. 4. Run the main script, using functions and variables from other scripts.
Exceptions/Alternates	● An included script file has an error—in this case, the error will be printed along with the filename.
Related UI	**See Sketch 1.B.**

Number	**Use Case 1.C.**
Title	**User Input in Commander**
Preparer	Eduardo Valdivia
Actor/User	Computer User
User Story	As a computer user, I want to be able to automate simple tasks. I want a program that can count the number of files in my Download folder and ask me whether I want to empty the contents in that folder.

Course of Events	1. Write a script in the Commander language using the **read** and **if** keywords to read user input and act on it. 2. Save the file. 3. Run the script with the Commander interpreter.
Exceptions/Alternates	None
Related UI	**See Sketch 1.C.**

Number	**Use Case 1.D.**
Title	**OS-specific Commands**
Preparer	Jaden Gill
Actor/User	Command Line User
User Story	As a command line user, I would like to be able to run a script on multiple operating systems, running the related commands on each operating system based on defined aliases so I don't have to rewrite the script to use different commands.
Course of Events	1. Create a script using aliases. 2. Run command in Linux, and use the corresponding Linux command. 3. Run command in Windows, and use the corresponding Windows command.
Exceptions/Alternates	● No command alias exists on the target platform - see 4.D.
Related UI	**See Sketch 1.D.**

Number	**Use Case 1.E.**
Title	**Loops in Commander**

Preparer	Eduardo Valdivia
Actor/User	Commander Scripter
User Story	As a Commander scripter, I would like to be able to run a command multiple times so I don't have to write it over and over.
Course of Events	1. Create a new file using a text editor. 2. Write a script using the **for** or **while** keywords.
Exceptions/ Alternates	• Do-While loops, implied loops, etc.
Related UI	**See Sketch 1.E.**

Number	**Use Case 1.F.**
Title	**Functional Programming**
Preparer	Preston Hales
Actor/User	Functional Programmer
User Story	As a functional programmer, I would like the ability to be able to store functions in variables and pass those functions into other functions as parameters in order to allow for better code reuse. Additionally, lambda expressions would be nice for defining functions on-the-fly.
Course of Events	1. Define function that use parameters as functions 2. Call those functions in that function 3. Call that function with either variables that store other functions, or by using a lambda expression to define a function for use in that one place.

Exceptions/Alternates	• None
Related UI	**See Sketch 1.F.**

Number	**Use Case 1.G.**
Title	**Advanced Command Execution Features**
Preparer	Preston Hales
Actor/User	Advanced Command-line Programmer
User Story	As an advanced command-line programmer, I'd like the ability to call commands with certain advanced features available in other command-line scripting languages (e.g. running commands in the background asynchronously), or even new features entirely, in order to give me more power to do what I need/want to do.
Course of Events	1. Run a command that can run in the background (i.e., asynchronously). 2. Run a command whose output can be piped into the input for another command. 3. Run a command and store output into a file. 4. Run a command, taking input from an existing file. 5. Run a command, and utilize the output of that command throughout the script (by storing it into a variable, or using it in some operation/expression). 6. Run a command that can output either standard output, error output, or both, to a file. 7. Run a command, and timeout the command if it takes too long. 8. Run a command, and detect if it succeeded or failed. 9. Run a command, and be able to specify what type the output is (e.g. a string, a boolean, an int, etc.).
Exceptions/Alternates	Possibly many other advanced features not currently listed here.
Related UI	**See Sketch 1.G.**

Number	Use Case 1.H.
Title	Scriptless Execution
Preparer	Cayden Lund
Actor/User	Terminal User
User Story	As a terminal user, I want to be able to write a short script of commands to execute without creating a temporary script file.
Course of Events	1. Write a short script of commands to execute in the format of a string. 2. Invoke the Commander executable with that string script as an argument. 3. The Commander executable interprets that argument as if it were read from a file.
Exceptions/Alternates	● If the script is malformed, errors will be reported in the same way as if it were read from a file. ● Compare with Python's scriptless evaluation: **python -c "print(2 ** 32)"**. ● Compare with directly executing a series of commands with logic in Bash or Zsh: **for dir in {tests,api,components}; do** **cp ./$dir/readme.md ./docs/$dir.md;** **done**
Related UI	See Sketch 1.H.

Number	Use Case 1.I
Title	User Defined Scopes
Preparer	Eduardo Valdivia
Actor/User	Scripter

User Story	As a scripter I sometimes want control of the scope of some variables. I do not want my "Index" variable to be reused by another process, for instance.
Course of Events	1. Create a Commander script. 2. Use symbol { to start the scope 3. Create variables 4. End scope with } (Variables defined in scope will be lost)
Exceptions/Alternates	Function scopes, main scope.
Related UI	**See Sketch 1.I**

Number	**Use Case 1.J**
Title	**Types and Operations**
Preparer	Eduardo Valdivia
Actor/User	Commander Scripter
User Story	As a Commander Scripter, I want my variables to have a type so I can perform certain operations with them.
Course of Events	1. Create a Commander script with some type specific operations, such as substring() for strings, or length() for arrays/tuples. 2. Run the script.
Exceptions/Alternates	None
Related UI	**See Sketch 1.J.**

Number	**Use Case 1.K.**
Title	**Script Syntax**
Preparer	Jaden Gill
Actor/User	Novice Commander Programmer
User Story	As a novice to Commander, I would like Commander to have familiar and easy to learn syntax so I don't have to spend a lot of time learning it.
Course of Events	1. Look at documentation on language to learn basic syntax, realizing it looks similar to languages like Javascript and C. 2. Use Commander to create a script based on a previous script written in Bash, realizing it is simpler to write the same code in Commander. 3. Run script in Commander interpreter.
Exceptions/Alternates	● None
Related UI	**See Sketch 1.K.**

Number	**Use Case 1.L.**
Title	**Multi-Platform Interaction**
Preparer	Jaden Gill
Actor/User	Programmer / user with multiple operating systems.
User Story	As a programmer that utilizes multiple operating systems, I would like to be able to run the scripts I write in multiple operating systems so that I don't have to rewrite my scripts to run in other operating systems.

Course of Events	1. Create a script file and distribute it to multiple machines. 2. For each machine, run the script and observe results. 3. The results will be similar or identical in most cases.
Exceptions/Alternates	● The script calls a method specific to an operating system - see use case 1.D. ● The script yields similar results, but not identical - see use case 4.D.
Related UI	**See Sketch 1.L.**

Number	**Use Case 2.A.**
Title	**Documentation and Examples**
Preparer	Cayden Lund
Actor/User	Language Learner
User Story	As someone unfamiliar with the Commander language, I want to learn the language and toolkit by reading the documentation and experimenting with provided examples.
Course of Events	1. Go through the documentation on the project's website (i.e., the GitLab repository). 2. Run some provided examples. 3. Adjust the examples in various ways, and observe how the adjustments affect the behavior of the examples. 4. Write new scripts based on the examples that do something useful and relevant to the user.
Exceptions/Alternates	None
Related UI	**See Sketch 2.A.**

Number	**Use Case 2.B.**

Title	**Multi-system Administration**
Preparer	Cayden Lund
Actor/User	Administrator of Multiple Systems
User Story	As the administrator of many computers (e.g., a computer lab or a workplace), I want to be able to write a script that will work on all of the managed computers. I may need to install software packages on systems that don't have that package, check that all firewalls are in working order, or run other logic as needed.
Course of Events	1. Install the Commander executable on all managed computers. 2. Write a script that will run checks, conditionally execute certain commands, and report to a central server. 3. Copy the script to each computer, and run it on each system. 4. Examine the reports and see the results.
Exceptions/Alternates	None.
Related UI	**See Sketch 2.B.**

Number	**Use Case 2.C.**
Title	**Project Bootstrapping**
Preparer	Cayden Lund
Actor/User	Toolchain Developer
User Story	As a developer of a specific toolchain, I want to write a script that will bootstrap a new project ready to integrate with this toolchain. This script will need to prompt the user with various questions and menu options.

Course of Events	1. Write a script that prompts the user with various questions. (project name, version, website, etc.). 2. The script then downloads base files from the internet. 3. Finally, the script auto-generates relevant files with the prompted information.
Exceptions/ Alternates	● Compare to **create-react-app** and **npm init**.
Related UI	**See Sketch 2.C.**

Number	**Use Case 3.A. (stretch goal)**
Title	**Syntax Highlighting**
Preparer	Preston Hales
Actor/User	Commander Scripter
User Story	As a Commander Scripter, I want to be able to write Commander scripts in the text editor or IDE that I like. I would also like the option to utilize syntax highlighting to make it easier to read and write.
Course of Events	1. Boot up text editor or IDE of choice with Commander syntax highlighting plugin. 2. Install Commander syntax highlighting plugin. 3. Write code that is more readable.
Exceptions/Alternates	● Won't work with all text editors, especially if they don't support plugins or don't have a Commander plugin available to use.
Related UI	**See Sketches 3.A.i, 3.A.ii, and 3.A.iii.**

Number	**Use Case 3.B. (stretch goal)**
Title	**Code Transpilation**
Preparer	Preston Hales
Actor/User	Commander Scripter
User Story	As a Commander Scripter, I want the option to be able to transpile my Commander code into Bash or Powershell so they can be directly executed in those respective shells on those respective operating systems.
Course of Events	1. Write Commander script 2. Run interpreter with **--bash** or **--powershell** flags, and the file path afterwards to signify where to save the transpiled code 3. Transfer new transpiled Bash or Powershell code to system of choice, and run them in their respective shells.
Exceptions/Alternates	● Not all shell languages will be supported.
Related UI	**See Sketch 3.B.**

Number	**Use Case 4.A.**
Title	**Syntax Errors**
Preparer	Eduardo Valdivia
Actor/User	Commander Scripter
User Story	As a Commander Scripter I would like feedback when I accidentally write syntax errors.

Course of Events	1. Create a Commander script with some syntax errors 2. Run the script 3. The Commander interpreter will throw error information.
Exceptions/ Alternates	• Getting errors/warnings while editing code (part of syntax highlighting plugins; stretch goal).
Related UI	**See Case 4.A.**

Number	**Use Case 4.B.**
Title	**Bad Interpreter Flag**
Preparer	Jaden Gill
Actor/User	Commander Script Runner
User Story	As a Commander script runner, I want it so that when I run the Commander interpreter and pass in an unknown flag such as --hello that it will display a helpful error message explaining that the flag does not exist.
Course of Events	1. Create Commander script. 2. Run Commander script through interpreter with **--hello**, an unknown flag. 3. The Commander interpreter displays an error: **Unknown flag '--hello'**
Exceptions/Alternates	• The flag is valid, in which case the interpreter just runs as normal.
Related UI	**See Sketch 4.B.**

Number	**Use Case 4.C.**
Title	**Variable Not Initialized**

Preparer	Jaden Gill
Actor/User	Programmer / Scripter
User Story	As a programmer, I would like for a helpful error to be displayed when I make a typo, such as when referencing a variable, so that I can know how to easily fix it.
Course of Events	1. Commander begins checking the script before execution. 2. Commander attempts to find initialization of each variable; “car” does not appear to have been initialized. 3. Checking stops, Commander throws an error such as “Type error: Variable ‘car’ has not been initialized”.
Exceptions/Alternates	● The script coincidentally has a variable named “car” which has already been initialized - See use case 1.I
Related UI	**See Sketch 4.C.**

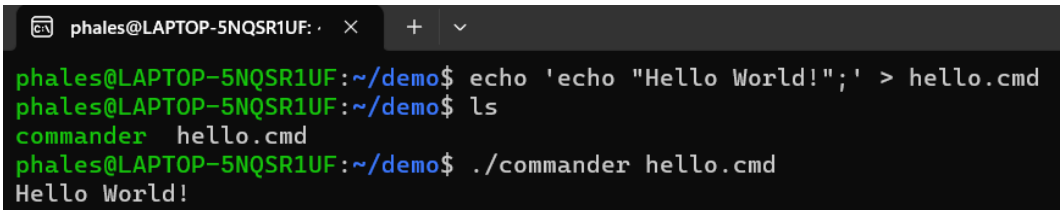
Number	**Use Case 4.D.**
Title	**No Command Aliases Exist**
Preparer	Jaden Gill
Actor/User	Scripting user
User Story	As a scripting user, I would like an error displayed when I try to use a command, such as **ar** (Linux), that does not exist on my current operating system (Windows).

Course of Events	1. Run the relevant script in Commander. 2. Commander encounters the unfamiliar command. 3. The command is passed to a lookup table of alternatives - the command exists on Linux but no such alternative exists for Windows. 4. The command will be highlighted in the editor paired with the error message "**Command `ar` not found. No alternatives exist.**"
Exceptions/Alternates	• An alternative command exists in the lookup table - See case 1.D.
Related UI	**See Sketch 4.D.**

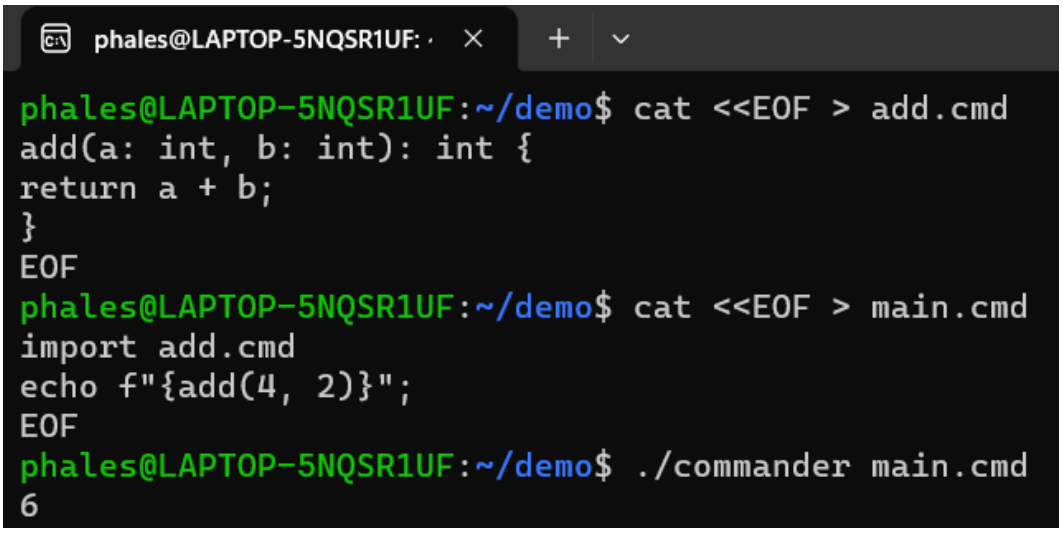
UI Sketches

1. Basic Functionality UI

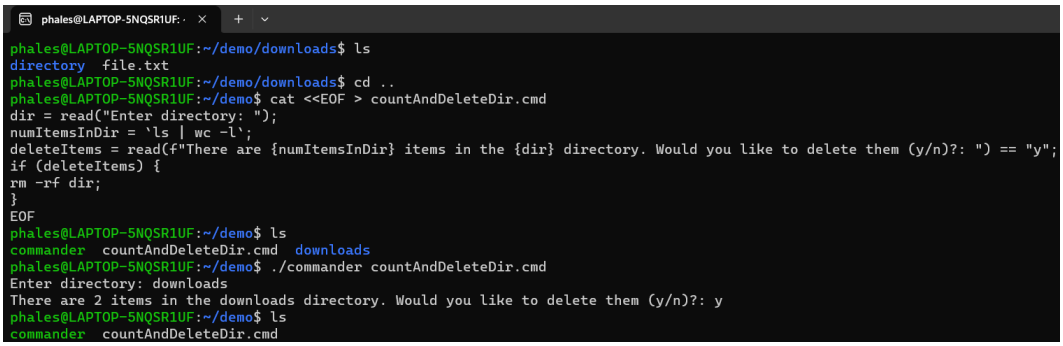
1.A. Running Script



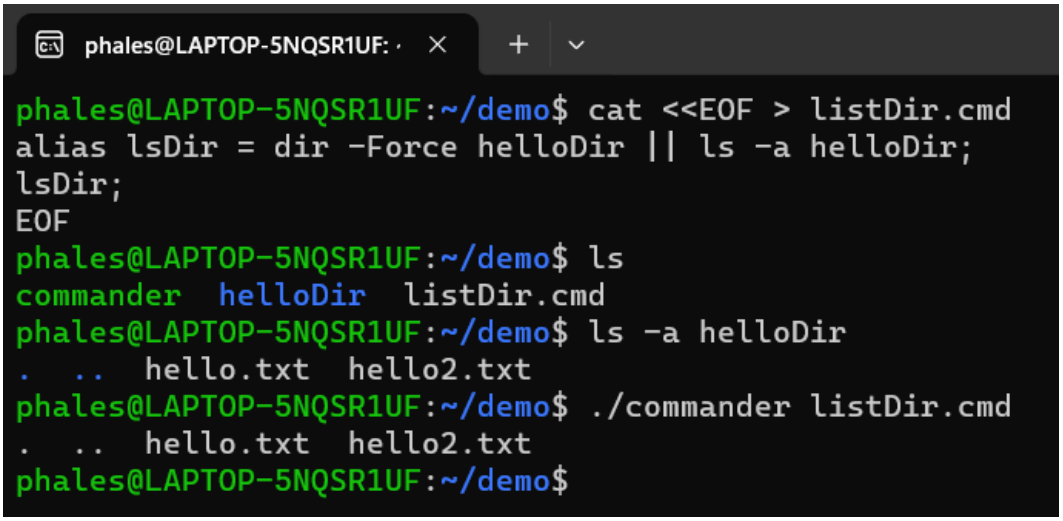
1.B. Multiple Scripts and Code Reuse



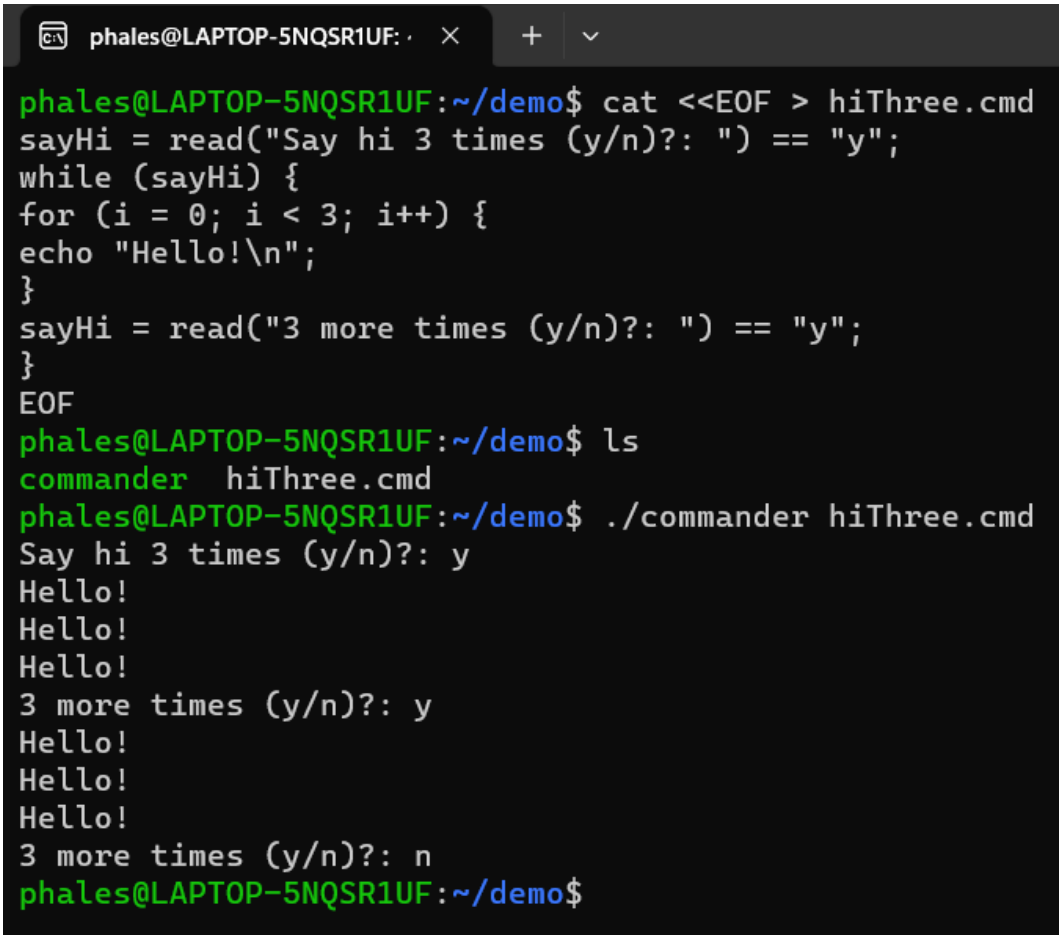
1.C. User Input in Commander



1.D. OS-specific Commands



1.E. Loops in Commander



1.F. Functional Programming

```
phales@LAPTOP-5NQSR1UF:~/demo$ cat <<EOF > ops.cmd
a = parseInt(read("Enter first number: "));
b = parseInt(read("Enter second number: "));
performOp(a: int, b: int, op: (int, int) => int): int {
return op(a, b);
}
//Add the two numbers
add = (x, y) => x + y;
echo f"Sum: {performOp(a, b, add)}\n";
//Subtract the two numbers
echo f"Difference: {performOp(a, b, (x, y) => x - y)}\n";
EOF
phales@LAPTOP-5NQSR1UF:~/demo$ ls
commander  ops.cmd
phales@LAPTOP-5NQSR1UF:~/demo$ ./commander ops.cmd
Enter first number: 5
Enter second number: 7
Sum: 12
Difference: -2
phales@LAPTOP-5NQSR1UF:~/demo$
```

1.G. Advanced Command Execution Features

```
phales@LAPTOP-5NQSR1UF:~/demo$ cat <<EOF > sample.txt
First Line
Second Line
Third Line
Fourth Line
Fifth Line
EOF
phales@LAPTOP-5NQSR1UF:~/demo$ cat <<EOF > countLines.cmd
try {
numLinesInFile = parseInt(`cat sample.txt | wc -l`);
printStd(f"There are {numLinesInFile} lines in sample.txt");
}
catch (1) {
printErr("Command failed, received error code 1; unable to count number of lines in sample.txt");
}
EOF
phales@LAPTOP-5NQSR1UF:~/demo$ ls
commander  countLines.cmd  sample.txt
phales@LAPTOP-5NQSR1UF:~/demo$ ./commander countLines.cmd
There are 5 lines in sample.txt
phales@LAPTOP-5NQSR1UF:~/demo$
```

1.H. Scriptless Execution

```
$ commander 'for (int num = 1; num <= 1024; num *= 4)
    ./simulate f"{num}"'
Simulating 1 object...
Simulating 4 objects...
Simulating 16 objects...
Simulating 64 objects...
Simulating 256 objects...
Simulating 1024 objects...
```

1.I User Defined Scopes

```
 1
 2 int x = 10;
 3
 4 { // Start of scope here
 5
 6     int y = 10;
 7
 8     echo f"x times y is: {x * y}"
 9
10 } // End of scope here
11
12 echo f"{y}" // ERROR!!
```

```
edd ~ $ ./commander scopes.cmd
Error in line 12: Unknown symbol y
edd ~ $
```

1.J. Types and Operations

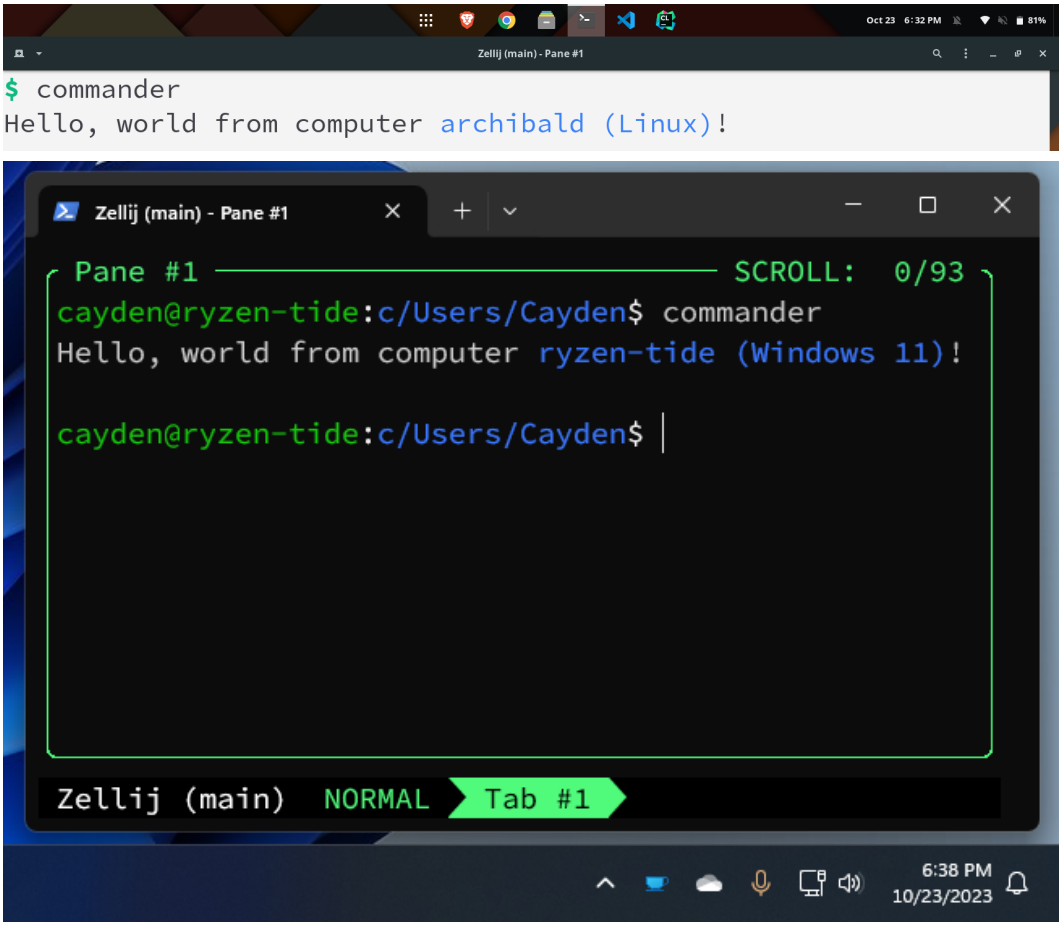
```
phales@LAPTOP-5NQSR1UF:~/demo$ cat <<EOF > types.cmd
myString = "Hello World!";
echo f"Substring: {myString.substring(0, 5)}";
myArray = [1, 2, 3];
echo f"Length: {myArray.length()}";
EOF
phales@LAPTOP-5NQSR1UF:~/demo$ ./commander types.cmd
Substring: Hello
Length: 3
phales@LAPTOP-5NQSR1UF:~/demo$
```

1.K. Commander Syntax

```
File Edit Options Buffers Tools Bat Help
sayHi = read("Say hi (y/n)?: ")
if (sayHi == "y") {
   echo "Hi!"
}
```

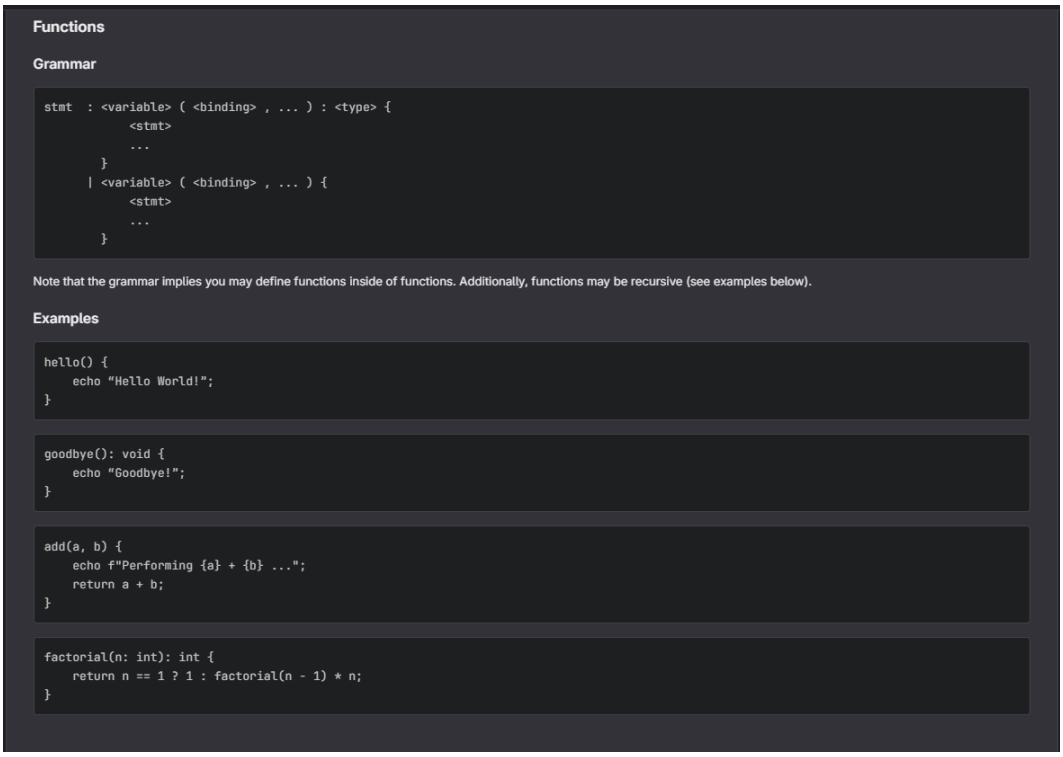
```
File Edit Options Buffers Tools
#!/bin/bash
read -p "Say hi (y/n)?: " sayHi
if [[ "$sayHi" == "y" ]]; then
    echo "Hi!"
fi
```

1.L. Multi-Platform Interaction



2. Documentation and External Functionality UI

2.A. Documentation and Examples



Functions

Grammar

```
stmt  : <variable> ( <binding> , ... ) : <type> {
            <stmt>
            ...
        }
      | <variable> ( <binding> , ... ) {
            <stmt>
            ...
        }
```

Note that the grammar implies you may define functions inside of functions. Additionally, functions may be recursive (see examples below).

Examples

```
hello() {
    echo "Hello World!";
}
```

```
goodbye(): void {
    echo "Goodbye!";
}
```

```
add(a, b) {
    echo f"Performing {a} + {b} ...";
    return a + b;
}
```

```
factorial(n: int): int {
    return n == 1 ? 1 : factorial(n - 1) * n;
}
```

2.B. Multi-system Administration

```
$ for computer in server-{0..6}.lab.domain;
do
    rsync run-updates.cmd admin@$computer:;
    ssh admin@$computer "commander run-updates.cmd";
done

Finished updates on server-0.lab.domain
Finished updates on server-1.lab.domain
Finished updates on server-2.lab.domain
Finished updates on server-3.lab.domain
Finished updates on server-4.lab.domain
Finished updates on server-5.lab.domain
Finished updates on server-6.lab.domain
```

2.C. Project Bootstrapping

```
phales@LAPTOP-5NQSR1UF:~/demo$ cat <<EOF > bootstrap.cmd
projectName = read("Project name: ");
version = read("Version: ");
website = read("Website: ");
directory = f"{projectName}-{version}";
mkdir directory;
cd directory;
wget website;
printStd(f"{projectName} successfully bootstrapped from {website} into {directory}.");
EOF
phales@LAPTOP-5NQSR1UF:~/demo$ ./commander bootstrap.cmd
Project name: Commander
Version: 1.0.0
Website: https://www.getcommander.com/download?version=1.0.0
Commander successfully bootstrapped from https://www.getcommander.com/download?version=1.0.0 into the directory Commander-1.0.0
phales@LAPTOP-5NQSR1UF:~/demo$ ls
Commander-1.0.0  bootstrap.cmd  commander
phales@LAPTOP-5NQSR1UF:~/demo$
```

3. Stretch Goals UI

3.A.i Syntax Highlighting I

```
phales@LAPTOP-5NQSR1UF:
File Edit Options Buffers Tools C++ Help
sayHi = read("Say hi 3 times (y/n)?: ") == "y";
while (sayHi) {
  for (i: int = 0; i < 3; i++) {
    echo "Hello!\n";
  }
  sayHi = read("3 more times (y/n)?: ") == "y";
}
```

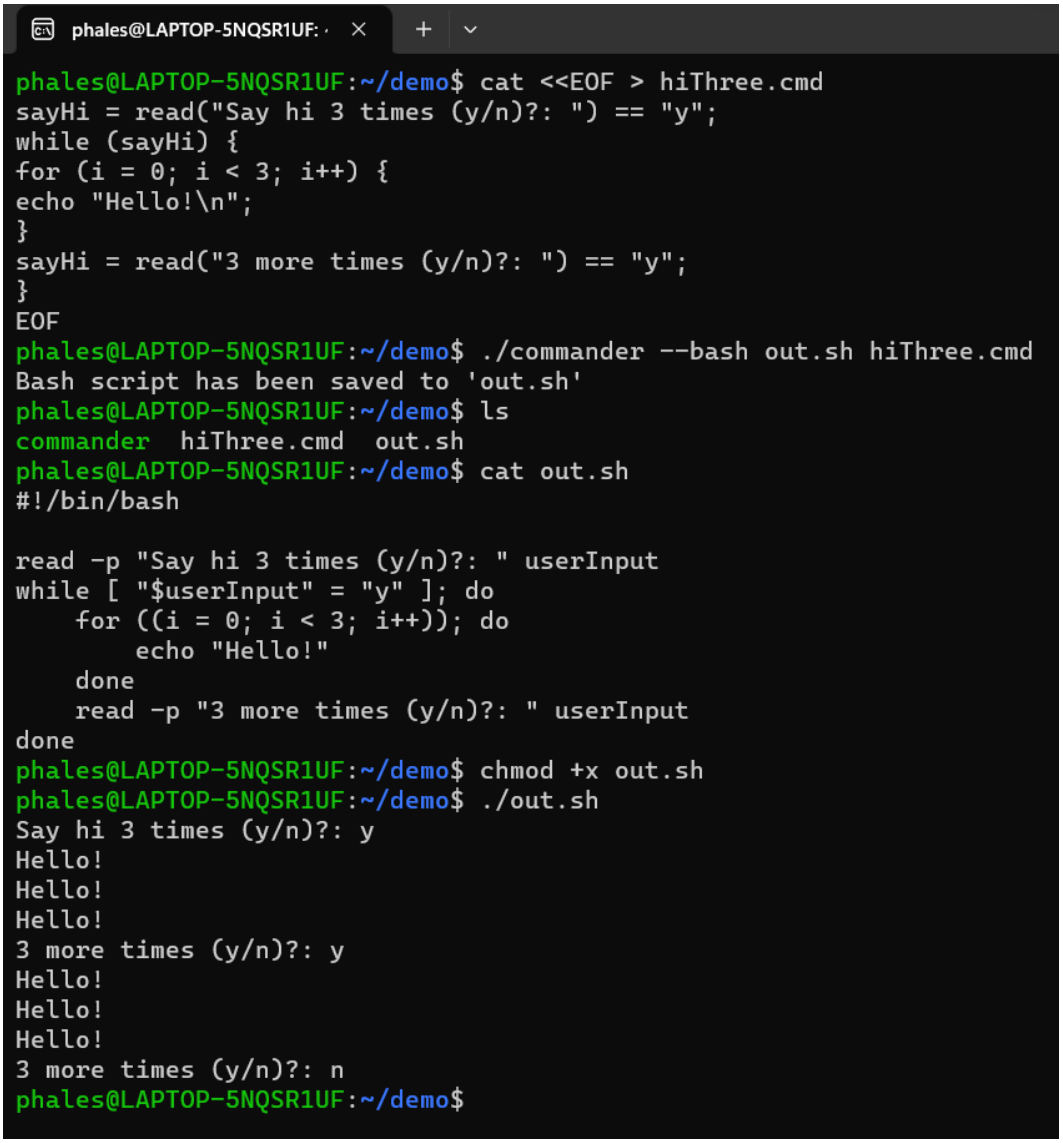
3.A.ii Syntax Highlighting II

```
1  sayHi = read("Say hi 3 times (y/n)?: ") == "y";
2  while (sayHi) {
3      for (i = 0; i < 3; i++) {
4          echo "Hello!\n";
5      }
6      sayHi = read("3 more times (y/n)?: ") == "y";
7  }
8
```

3.A.iii Syntax Highlighting III

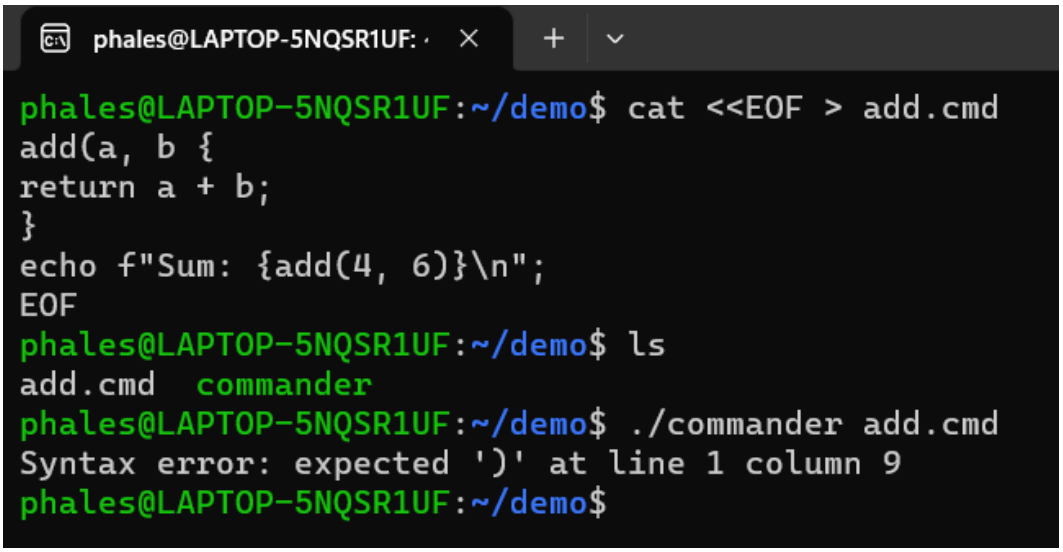
```
hiThree.cmd
1  sayHi = read("Say hi 3 times (y/n)?: ") == "y";
2  while (sayHi) {
3      for (i = 0; i < 3; i++) {
4          echo "Hello!\n";
5      }
6      sayHi = read("3 more times (y/n)?: ") == "y";
7  }
```

3.B. Code Transpilation

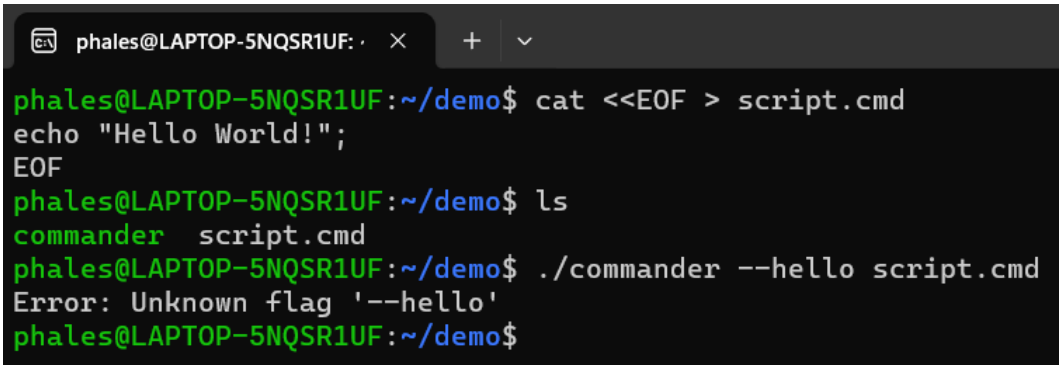


4. Error Handling and Edge Cases UI

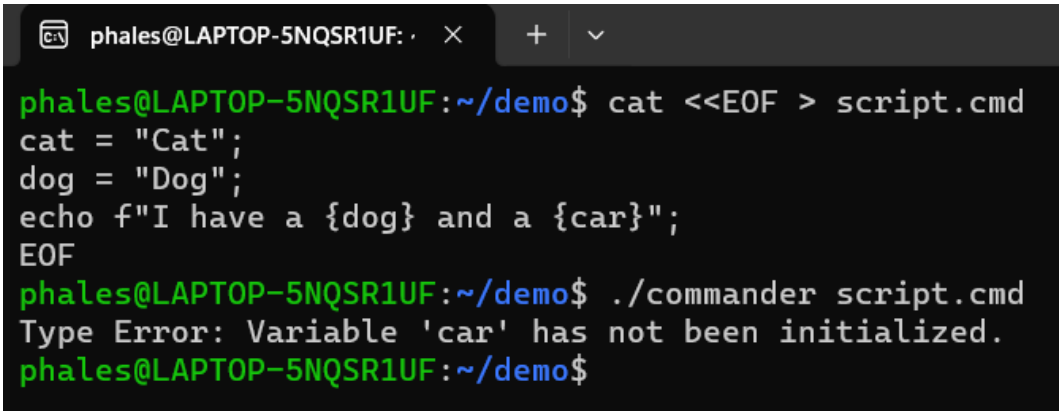
4.A. Syntax Errors



4.B. Bad Interpreter Flag



4.C. Variable Not Initialized



4.D. No Command Aliases Exist

```
$ commander script.cmd
Error at 4:1: Command `ar` not found.
              No alternatives exist.

 4:  ar cr libfantastic.a api.o backend.o middleware.o
     ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
```

Revisions

1. Executive Summary
    a. No changes
2. Background and Technical Requirements
    a. No changes
3. Requirements Analysis
    a. 12/10/23 - Update section to not use bullet points to be more consistent to how the rest of the document is formatted.
4. Timeline
    a. 11/27/23 - Added the section and filled it out
5. Appendix
    a. 11/27/23 - Added revision section and filled it out