Assignment 1 Document

Atomic lexical elements of the language

Element		**Expression**
id	::=	letter alphanum*
alphanum	::=	letter | digit | _
integer	::=	nonzero digit* | 0
float	::=	integer fraction [**e**[+|−] integer]
fraction	::=	.digit* nonzero | **.0**
letter	::=	**a..z | A..Z**
digit	::=	**0..9**
nonzero	::=	**1..9**
string	::=	“ alphanum “
character	::=	alphanum

Operators, punctuation and reserved words

==	+	|	(	;	if	public	read
<>	-	&	)	,	then	private	write
<	*	!	{	.	else	func	return
>	/	?	}	:	integer	var	main
<=	=		[	::	float	class	inherits
>=			]	"	string	while	break
					void		continue

Comments

- Block comments start with /* and end with */ and may span over multiple lines.
- Inline comments start with // and end with the end of the line they appear in.

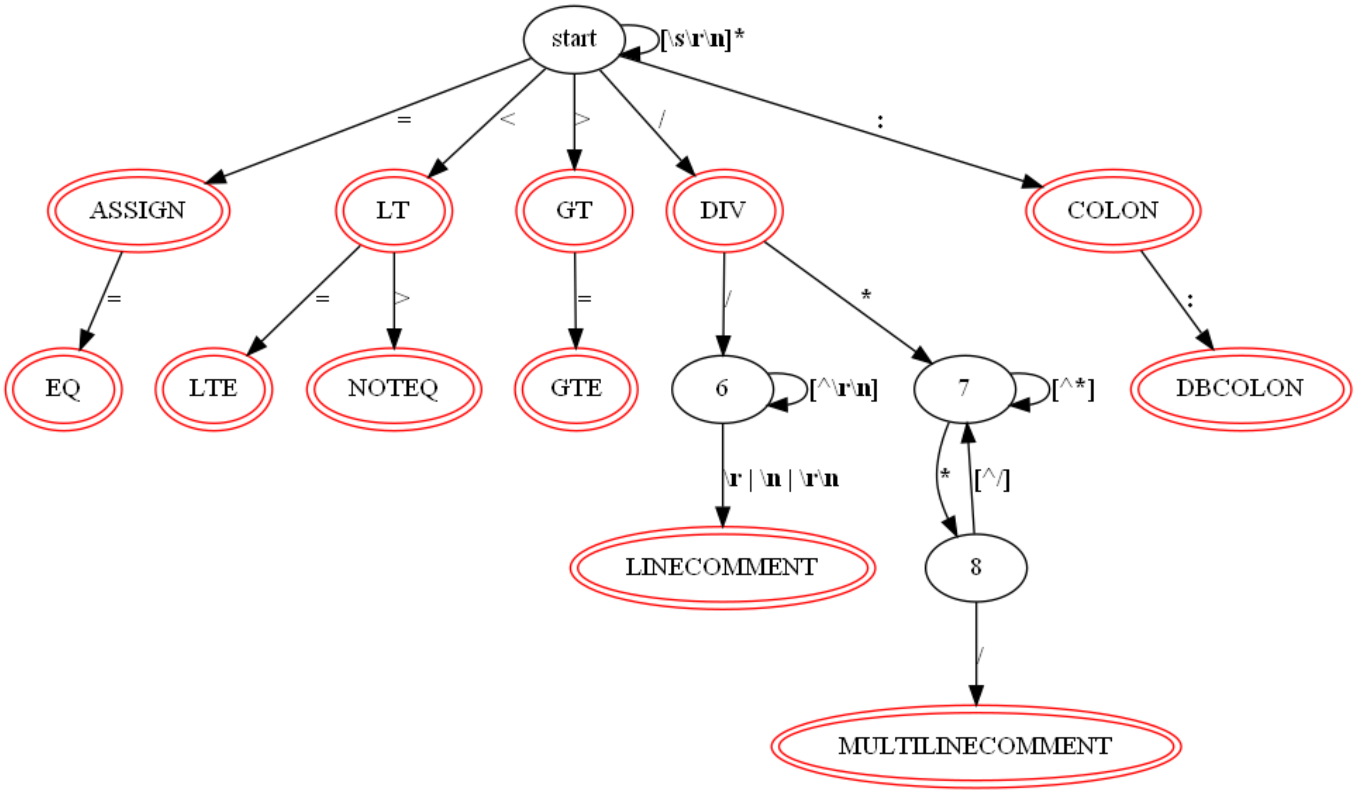
Lexical Specification

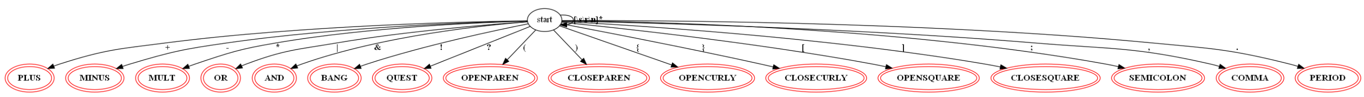
- **id**: `^[a..zA..Z]([a..zA..Z] | [0..9] | _ )*`
- **integer**: `^[1..9][0..9]* | ^(0)`

- **string**: `"([a..zA..Z] | [0..9] | _ | space)*"`
- **float**: `(^[1..9][0..9]* | ^(0))\.([0..9]*[1..9] | 0)(e(+ | -)?[1..9][0..9]* | 0)`
- **For operators, punctuation and reserved keywords**: Can match directly based on above tables.
- **Single line comments**: `//[^\r\n]*`
- **Multiline comments**: `\*.*?\*/`

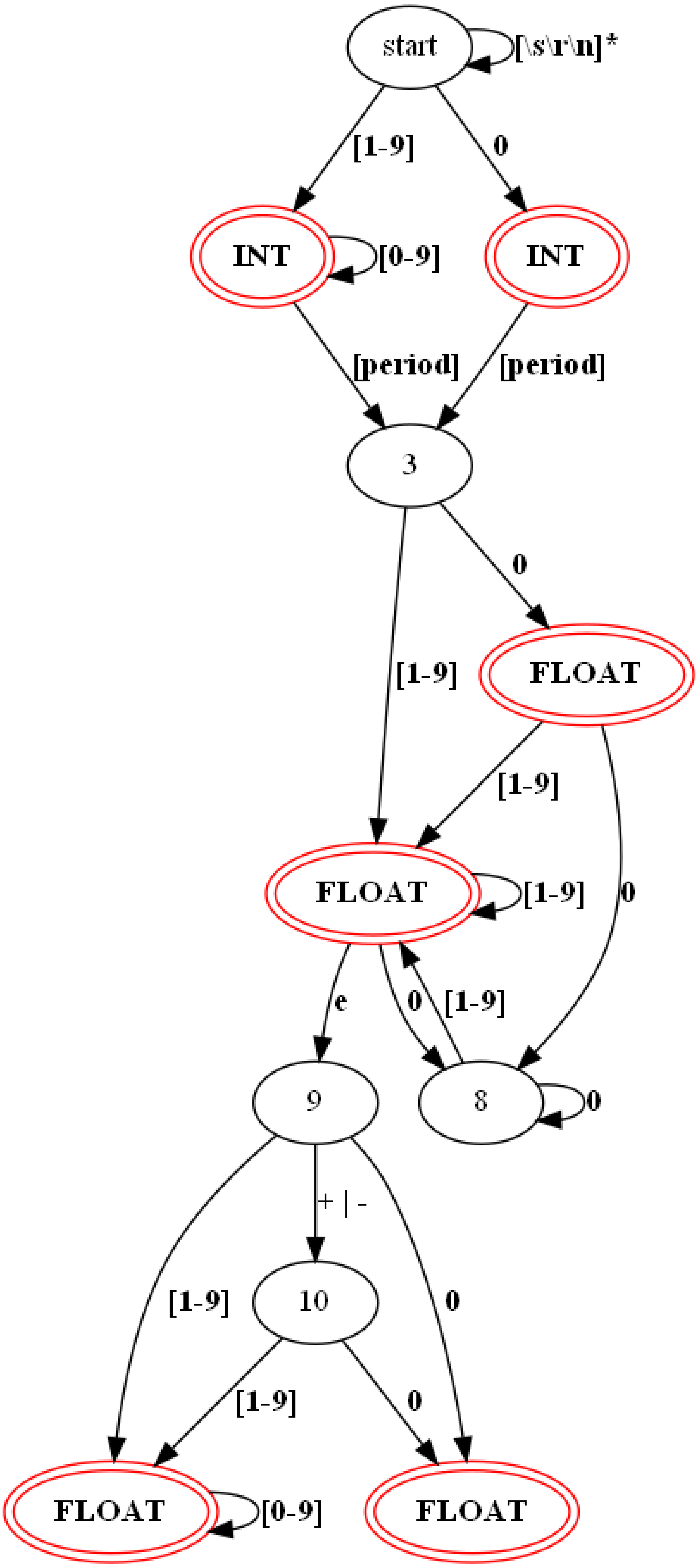
Finite State Automatons

Finite Automaton for Operators, Punctuation and Comment tokens

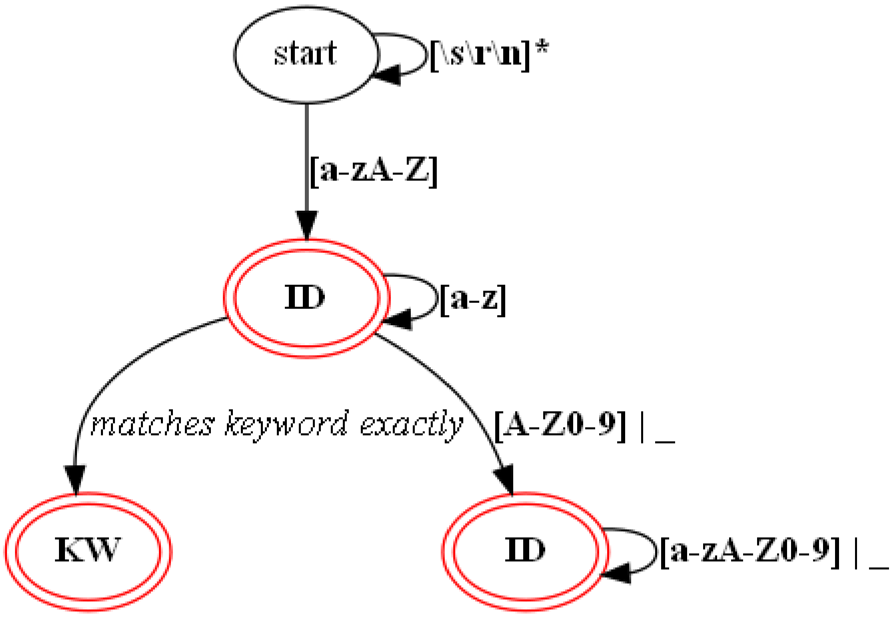




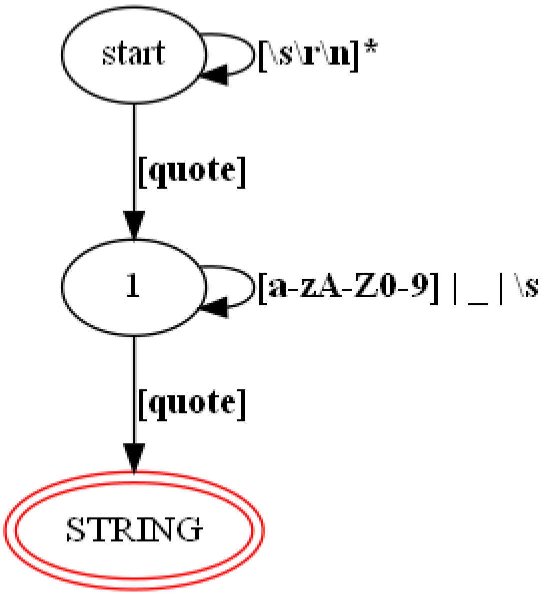
Finite Automaton for Integer and Float tokens



Finite Automaton for ID and Keyword tokens



Finite Automaton for String tokens



Design

For this project, I have chosen to implement the compiler in the Rust programming language.

In the `token.rs` file, I have defined an enum `TokenType` with every variant representing a token the compiler supports, including the Error token type. Each token type is attached to a regular expression, which are defined in the `token_regex.rs` file. These regexes can be used to test an input to see if it corresponds to a specific token. For the `TokenType::Error` variant, it holds a variant of the `InvalidTokenType` enum, which represents the different possible error tokens.

The `Token` struct represents a fully parsed token, which includes the type of token, the lexeme and the line number where the token is. I have grouped up the token type and the lexeme into it's own struct called `TokenFragment` so that callers have a way to have a "Token" without a line number.

In the `lexer.rs` file is my implementation of a Lexer. I have defined a the trait (Similar to a Java interface or a pure virtual C++ class) `LexerAnalyzer` which describes an interface of possible operations for a Lexer. I have a struct called `LexerInput` which wraps a `String` and provides easy ways to construct an input for my Lexer either from a string or from a file. Finally, I've implemented a Lexer through the struct `MyLexerAnalyzer` which implements the `Lexer` trait and owns a `input: LexerInput`, the input to lex, and a `idx: usize` which keeps track of where in the input we are.

In the `utils.rs` file, I have a few functions that help the Lexer parse the input.
The `is_valid_character` function is used to know if the next character will possibly lead to a punctuation, operator or comment token.
The `serialize_lexer_to_file` function takes in the lexer to serialize to a file and the filename to output to.
The `parse_kw_or_id` function takes in the input string to parse, and returns either a keyword, id or error token.
The `parse_number` function takes in the input string to parse, and returns either an integer, float or error token.
The `parse_op_or_punct` function takes in the input string to parse, and return either a punctuation, operator, comment or error token.
The `parse_string` function takes in the input string to parse, and return either a string or error token.

Use of tools

- The Rust programming language: I chose to implement the compiler in Rust. Rust is a multi-paradigm programming language that guarentees memory safety, is relatively fast (similar to C/C++) and provides powerful tools to build a compiler (pattern matching, algebreic data types, etc...). I also had a bit of familiarity with the language and wanted to further my own proficiency in it.

- Crates (Rust equivalent of libraries):

  - Regex: This crate provides a library for parsing, compiling, and executing regular expressions, which is useful when testing a lexeme for a token.
  - Lazy Static: Since you cannot declare/initialize static file variables (like C++), this crate provides a macro that enables you to do so. I use this to mostly in conjuction with the `Regex` crate so that my regular expressions are precompiled and available to any file in my project.
  - StructOpt: This crate allows me to easily create a CLI for my compiler by simply defining a struct of possible command line arguments.

- Other tools:

  - CLion: My IDE of choice for writing Rust.
  - Git/Github: VCS
  - VSCode: Mostly for text editing and visualizing non-text files.
  - Regex 101: To test my regexes.
  - GraphViz: For creating the Finite Automatons required for the assignment.