Formal Languages and Compiler Design

Overview

You can find the source code of this assignment here.

Representation

The chosen representation for the symbol table is a balanced binary search tree, implemented using a red black tree. A good overview of the red black tree data structure can be found here.

Used Regex

- Separators Regex: \,|\;|\:|\}|\]|\[|\{|\)|\(|\$
    - Generated depending on the input from tokens.in
- Operators Regex: + | - | * | / | % | = | < | <= | == | > | >= | != | ! | and | or
- Identifiers Regex: ^([a-zA-Z])[a-zA-Z0-9]*$
- Constants Regex:
    - Negative Integers: ^\-[1-9][0-9]*$
    - Positive Integers: ^\+[1-9][0-9]*$
    - Unsigned Integers: ^[1-9][0-9]*|0$
    - Character: ^'[a-zA-Z0-9]?'$
    - String: ^"[a-zA-Z0-9]*"$

Documentation

SymbolTable

- int retrievePosition(const std::string& element)
    - Gets the position of the given element in the symbol table. If the element is not presented in the symbol table, then insert it first
    - In the context of the red black tree implementation of the symbol tree, the position of the element is defined as the position of the element in the sorted array

Scanner

- Scanner(const std::string& inputFilePath, const std::string& tokensFilePath)
- void scan()
    - Scans the input program, populates the PIF.out and ST.out files and prints a message to the standard output specifying if the program is lexically correct or not

- void scanTokens()
    - Scans and identifies the tokens
- std::string buildOrRegex(const std::unordered_set<std::string>& elements)
    - Builds a regex by taking each element from the given set and adding an or ("|") between each pair of elements
- void splitByOperators(std::string currentStr, int lineNumber)
    - Splits the given string by operators
- void splitByOperatorsRecursively(const std::string& multipleCharsOperatorsRegex, const std::string& singleCharOperatorsRegex, std::string currentStr, int lineNumber, bool isMultipleCharsStep = true)
    - Helper function for splitting the given string by operators
- void handleToken(std::string token, int lineNumber)
    - Handles the given token, by populating the updating the PIF and ST instances
- TokenType identifyToken(const std::string& token, int lineNumber)
    - Attempts to identify the given token
    - If the token cannot be identified, throws an exception

ProgramInternalForm

- ProgramInternalForm(const std::string& outFilePath)
- int push(const std::string& token, int position)
    - Adds a new (token, position) pair to the PIF
- ProgramInternalForm(const std::string& outFilePath)
- void getPifInFile()
    - Saves the current PIF in a file
- const std::vector<std::pair<std::string, int>> getPif()
    - Returns the PIF underlying data structure

RedBlackTree<K, Node>

- void insert(const K& key)
    - Inserts the element in the red black tree
- void remove(const K& key)
    - Removes the element from the red black tree
- Node* search(const K& key)
    - Searches the given key in the red black tree
    - If found, it returns a pointer to the corresponding node
- const K& minimum()
    - Returns the minimum in the red black tree
- const K& maximum()
    - Retuns the maximum in the red black tree
- int size()
    - Returns the size of the red black tree
- Node* root()
    - Retuns a pointer to the node corresponding to the root of the red black tree

Node<K>

- const K& getKey()
    - Returns the key corresponding to the node
- Node* getParent()
    - Returns the parent of the node
- Node* getLeftChild()
    - Returns the left child of the node
- Node* getRightChild()
    - Returns the right child of the node
- bool getColor()
    - Returns the color of the node

Production

- std::string toString()
    - return the string representation of the production
- friend bool operator<(const Production &el, const Production &other)
- const std::string& getSource()
- const std::vector<std::string>& getDestinations()

Grammar

- void parse(const std::string &file_path)
    - parse the input grammar
- const std::vector<std::string> &getNonTerminals()
- const std::vector<std::string> &getTerminals()
- const std::vector<Production> &getProductions()
- const std::string &getStartingSymbol()
- bool checkCFG() const;

ParsingTableRow

- ParsingTableRow(const std::string& symbol, int parentIndex)

ParserOutput

- ParserOutput(const ParserTree& parserTree)
- void loadFromParserTree(const ParserTree& parserTree)
    - creates the parser output from the parsing tree
- bool getIsValidInput() const;
- void setIsInvalidInput();

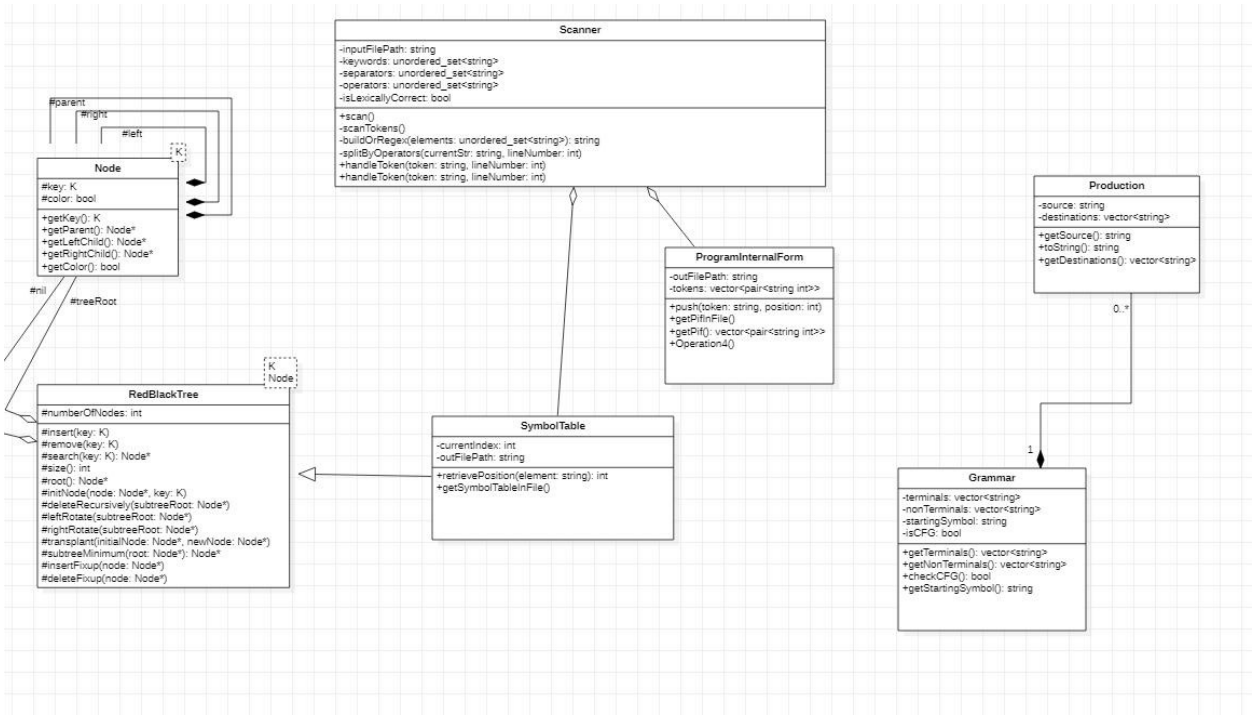
RecursiveParserState

- NORMAL
- BACK
- FINAL
- ERROR

RecursiveParser

- ParserOutput parse(const std::vector<std::string>& inputSequence)
    - Parses the input sequence based on a given grammar using the recursive descent algorithm
- void expand()
- void advance()
- void momentaryInsuccess()
- void back()
- void anotherTry()
- void success()
- bool checkNextProductionIndex(int productionIndex, const std::string& src)
- void insertNextProduction(int productionIndex, const std::string& src)
- ParserTree createParserTree()

Class Diagram



BNF for FA.in

letter ::= "a" | "b" | ... | "z"
digit ::= "0" | "1" |...| "9"
character ::= digit | letter
qualifier ::= letter character*
transition ::= "(" qualifier "," character "->" qualifier ")"
initialState ::= "q0 = " qualifier
finalStates ::= "F = {" (qualifier "\n")+ "}"
alphabet ::= "E = {" (character "\n")+ "}"
states ::= "Q = {" (qualifier "\n")+ "}"
transitions ::= "T = {" (transition "\n)"+ "}"
fa ::= states "\n"+ alphabet "\n"+ transitions "\
n"+ initialState "\n"+ finalStates