كليـــــة الحاسبات والذكاء الاصطناعي

كونترول الفرقة ....الثالثة...........

العــام الجامعـــى 2019 / 2020 – دور مايـــو

الغلاف الخارجى للبحث

أولاً: البيانات الخاصة بالطالب			
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ثانياً: البيانات الخاصة بالبحث			
عنوان البحث	Scanner and Parser for Language 1		
طبيعة المشاركة	بحث فردى	بحث جماعى	*
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تاريخ الإرسال	9 / 6 / 2020			

ثالثاً: البيانات الخاصة بالكونترول				
النتيجة	ناجح		راسب	

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Contents

1. Introduction

We created Language 1, we used LL1 parser with table and stack and some other data structure and.

First, we have created the scanner and gave to every token some properties like token type, line number, and pattern,

Then, we created a simple BNF grammar and we handled the dangling-else problem with brackets, and also we used left-factoring and left-recursive grammar to convert BNF grammar to LL1 grammar to avoid ambiguous rules.

Then, we used the dictionary data structure to handle some errors like when a user uses a variable that does not exist or declares a variable more than ones, and also we handled syntax error with some description.

2. Language description

Language 1,

A program in this language consists of a main C function in which you can:

• Declare integer, floating point and character variables.

• Perform an assignment statement where the right-hand-side may be a constant, single variable or expression (including +,-,*, / operators as well as ()).

• Perform an if/if-else statement which may include any number of assignment statements and if/if-else statements in any order. The condition of the if/if-else statement may include >,<,>=,<=,==,!= and ().

• In general, main function may include any number of assignment and if/if-else statements in any order and as described above.

This's the language in a simple way without much details.

- if statement (else is not necessary for every if)
```
 If (condition)
         {statement ;}
 Else
         {statement ;}
```

- Assignment statement
  Identifier = value or expression ;

- Declare statement
  Datatype identifier = value or another identifier or expression;

- Datatype
  Float, int, char

- Symbols = (,), <, >, =, <=, >=, ==, !=, *, /, +, -, }, {, ;, $

3. Source code & Testing it

Google drive link: https://drive.google.com/drive/folders/1-IPE2fzrnfda0jNWnFryonJlOjQwXpxh?usp=sharing

Implemented source code

1- Main Class

```java
2- import Parser.Parser;
   import Scanner.*;

   import java.io.File;
   import java.io.FileNotFoundException;

   public class Main {
       public static void main(String[] args) throws Exception {
           String path_to_file = "src/test case5.txt";
           // Read code from the file
           String code = readFile(path_to_file);

           Parser parser = new Parser(new Scanner(code));
           parser.start();

           /*
           // testing the scanner
           Scanner scanner = new Scanner(code);
           while(scanner.hasNestToken()){
               Token token = scanner.nextToken();
               // these tokens and their types
               System.out.print(token.getToken());
               System.out.print(" "+token.getType());
               System.out.println(" "+token.getLine());
           }
           */

       }

       private static String readFile(String path){
           String code = "";
           try {
               File file = new File(path);
               java.util.Scanner scanner = new java.util.Scanner(file);
               int i = 1;
               while (scanner.hasNextLine()){
                   String line = scanner.nextLine();
                   code += line + "\n" ;
                   ++i;
               }
               scanner.close();
           }catch (FileNotFoundException e){
               System.out.println(e);
           }
           return code;
       }
   }
```

2- Scanner Class

```
3-  package Scanner;

    import java.util.ArrayList;
    import java.util.regex.Matcher;
    import java.util.regex.Pattern;

    /**
     * what you will receive from this class? Are all tokens in the file you sent to
    the constructor as a string
     */
    public class Scanner {
        // array list contains types of tokens and their patterns
        private ArrayList<TokenInfo> tokensTypes;
        //Code of strings to scan
        private String file;
        // counter to track line for each token
        private int counter = 1;
        public Scanner(String file){
            this.tokensTypes = new ArrayList<TokenInfo>();
            // remove space and new line from first and end of string
            this.file = file + "$";
            prepareTokensInfo();
        }

        private void prepareTokensInfo()
        {
            // For identifiers
            tokensTypes.add(new TokenInfo(Pattern.compile("^(([a-zA-Z]([_]|[a-zA-Z0-
    9])*))"), TokenType.IDENTIFIER));
            // For float value
            tokensTypes.add(new TokenInfo(Pattern.compile("^((-)?[0-9]+(.)[0-9]+)"),
    TokenType.FLOAT));
            // For integer value
            tokensTypes.add(new TokenInfo(Pattern.compile("^((-)?[0-9]+)"),
    TokenType.INTEGER));
            // For Char value
            tokensTypes.add(new TokenInfo(Pattern.compile("^(\'(\\w|\\s)\')"),
    TokenType.CHAR));
            // For Datatype
            tokensTypes.add(new TokenInfo(Pattern.compile("^(int|float|char)"),
    TokenType.DATATYPE));
            //others
            for(String token : new String[] {">=", "<=", "==", "=", "!=","<", ">",
    ",","\\(", "\\)", "\\{", "\\}", "if", "else", "!", "\\+", "\\-", "\\/", "\\*",
    "main", ";", "\\$"})
                tokensTypes.add(new TokenInfo(Pattern.compile("^(" + token + ")"),
    TokenType.TOKEN));

        }

        public Token nextToken(){
            // if it's new line so increase counter by 1
            if(file.charAt(0) == '\n')
                this.counter +=1;

            // remove space and new line from first and end of string
```

```java
        file= file.trim();

        //loop over RE to find or match current token
        for(TokenInfo tokenInfo : tokensTypes)
        {
            Matcher matcher = tokenInfo.getPattern().matcher(file);

            // if it's matches then remove this token from string file or code
            if(matcher.find()){
                String  token = matcher.group();
                file = matcher.replaceFirst("");

                //Prepare tokens to parser or next phase
               return PrepareToken(tokenInfo, token);
            }
        }

        throw new IllegalStateException("Could not scan line " + counter);
    }

    /**
     * @param tokenInfo
     * @param token
     * @return Token
     */
    private Token PrepareToken(TokenInfo tokenInfo, String token){
        //correct token type
        if(token.equals("int") || token.equals("char") ||token.equals("float"))
           return new Token(token, tokenInfo.getPattern(), TokenType.DATATYPE,
counter);

        if(token.equals("if") || token.equals("else") ||token.equals("main"))
            return new Token(token, tokenInfo.getPattern(), TokenType.TOKEN,
counter);

        //check if token is char then skip first and last char ''
        if(tokenInfo.getTokenType() == TokenType.CHAR)
            return  new Token(token.substring(1, token.length() - 1),
tokenInfo.getPattern(), tokenInfo.getTokenType(), counter);

        return new Token(token, tokenInfo.getPattern(), tokenInfo.getTokenType(),
counter);
    }

    public boolean hasNestToken(){
        return !this.file.isEmpty();
    }
}
```

3- Token Class

```
4- package Scanner;
   import java.util.regex.Pattern;
   public class Token {
       private String token;
       private Pattern pattern;
       private TokenType type;
       private int line;
       public  Token(String token, Pattern pattern, TokenType type, int line)
       {
           this.pattern = pattern;
           this.token = token;
           this.type = type;
           this.line = line;
       }

       public Pattern getPattern() {
           return pattern;
       }

       public int getLine() {
           return line;
       }

       public String getToken() {
           return token;
       }

       public TokenType getType() {
           return type;
       }
   }
```

5- TokenInfo Class

```
6-  package Scanner;
    import java.util.regex.Pattern;
    public class TokenInfo {
        private Pattern pattern;
        private TokenType tokenType;
        public TokenInfo(Pattern pattern, TokenType tokenType){
            this.pattern = pattern;
            this.tokenType = tokenType;
        }

        public Pattern getPattern() {
            return pattern;
        }

        public TokenType getTokenType() {
            return tokenType;
        }

        public void setTokenType(TokenType tokenType) {
            this.tokenType = tokenType;
        }
    }
```

6- TokenType Enum

```
7-  package Scanner;

    public enum TokenType {
        TOKEN,
        IDENTIFIER,
        DATATYPE,
        INTEGER,
        CHAR,
        FLOAT
    }
```

7- Parser Class

```
8- package Parser;

   import Scanner.*;
   import com.sun.org.apache.xpath.internal.objects.XString;
   import javafx.util.Pair;

   import java.util.Enumeration;
   import java.util.Hashtable;
   import java.util.Stack;
   import java.util.Dictionary;

   public class Parser {
       private final Scanner scanner;
       private Stack<String> stack;
       private Token cur_token;
       private Dictionary<String, String> dictionary;
       public static String expecting;
       private boolean flag = true;

       // constructor
       public Parser(Scanner scanner){
           this.scanner = scanner;
           this.stack = new Stack<String>();
           this.dictionary = new Hashtable<>();
       }

       /**
        * function to start parsing the code
        */
       public void start() {
           // check if the code is empty or not
           if(!scanner.hasNestToken())
               return;
           // get the first token
           cur_token = scanner.nextToken();
           stack.push("$");
           stack.push("}");
           // program is the start point
           stack.push("program");
           stack.push("{");
           stack.push(")");
           stack.push("(");
           stack.push("main");
           stack.push("int");
           while(!stack.empty()){
               match();
           }
       }

       /**
        * function to decide what next or what non terminal is gonna to release
        */
       private void match(){
           // this is correct case where stack has only $ and last token is $
           if(stack.peek().equals("$") && cur_token.getToken().equals("$")){
               System.out.println("SUCCESS");
               stack.pop();
               return;
           }
           else if (cur_token.getType() == TokenType.DATATYPE &&
   (stack.peek().equals("float") || stack.peek().equals("char") ||
   stack.peek().equals("int")))
           {
               cur_token = scanner.nextToken();
               // add a new identifier to the dictionary
               putNewIdentifier(cur_token.getToken(), stack.peek(), cur_token);
               stack.pop();
           }
           // cases
           else if (cur_token.getToken().equals(stack.peek()))
           {
               cur_token = scanner.nextToken();
               stack.pop();
           } else if (cur_token.getType() == TokenType.IDENTIFIER &&
   stack.peek().equals("id"))
           {
               // check if the identifier is declared or not before if not then
   that's an error
               if(!checkIdentifier(cur_token))
                   ERROR.notDefinedError(cur_token);
               cur_token = scanner.nextToken();
               stack.pop();
           } else if ((cur_token.getType() == TokenType.INTEGER ||
   cur_token.getType() == TokenType.CHAR || cur_token.getType() == TokenType.FLOAT)
                   && stack.peek().equals("value"))
           {
               cur_token = scanner.nextToken();
               stack.pop();
           }
           else {
               //System.out.println(stack.peek() +" " +cur_token.getToken());
               try {
                   // getting the top of the stack to expect the error
                   expecting = stack.peek();
                   // use the name of expression to call the appropriate function
                   Parser.class.getMethod(stack.pop()).invoke(this);
               } catch (Exception e) {
                   // catch error in the code
                   ERROR.syntaxError(cur_token);
               }
           }
       }

       /**
        * these all the non terminals in the grammar and each non terminal has
   release of terminal or not
        */
       //1-
       public void program(){
           if(cur_token.getToken().equals("if") || cur_token.getType() ==
   TokenType.IDENTIFIER ||
           cur_token.getType() == TokenType.DATATYPE)
               stack.push("stmt_seq");
           else
               ERROR.syntaxError(cur_token);
       }
       //2-
       public void stmt_seq(){
           if(cur_token.getToken().equals("if") || cur_token.getType() ==
   TokenType.IDENTIFIER ||
                   cur_token.getType() == TokenType.DATATYPE) {
```

```
                stack.push("stmt_seq2");
                stack.push("stmt");
            }
            else
                ERROR.syntaxError(cur_token);
        }
        //3-
        public void stmt_seq2(){
            if(!cur_token.getToken().equals("if") && cur_token.getType() !=
    TokenType.IDENTIFIER &&
                    cur_token.getType() != TokenType.DATATYPE &&
    !cur_token.getToken().equals("}") && !cur_token.getToken().equals("$"))
                ERROR.syntaxError(cur_token);
            else if(cur_token.getToken().equals("}") ||
    cur_token.getToken().equals("$"))
                Epsilon();

            else
                stack.push("stmt_seq");
        }
        //4-
        public void stmt(){
            if(cur_token.getToken().equals("if"))
                stack.push("if_stmt");
            else if(cur_token.getType() == TokenType.IDENTIFIER)
                stack.push("assign_stmt");
            else if (cur_token.getType() == TokenType.DATATYPE)
                stack.push("declare_stmt");
            else
                ERROR.syntaxError(cur_token);
        }
        //5-
        public void if_stmt(){
            if(cur_token.getToken().equals("if")) {
                stack.push("else_part");
                stack.push("}");
                stack.push("stmt_seq2");
                stack.push("{");
                stack.push(")");
                stack.push("condition");
                stack.push("(");
                stack.push("if");
            }
            else
                ERROR.syntaxError(cur_token);
        }
        //6-
        public void else_part(){
            if(cur_token.getToken().equals("else")){
                stack.push("}");
                stack.push("stmt_seq2");
                stack.push("{");
                stack.push("else");
            }
            else if (cur_token.getToken().equals("if") || cur_token.getType() ==
    TokenType.IDENTIFIER
            || cur_token.getType() == TokenType.DATATYPE ||
    cur_token.getToken().equals("$") || cur_token.getToken().equals("}"))
                Epsilon();
            else
                ERROR.syntaxError(cur_token);
        }
        //7-
        public void condition(){
            if(cur_token.getType() == TokenType.IDENTIFIER ||
                    cur_token.getType() == TokenType.INTEGER || cur_token.getType() ==
    TokenType.FLOAT
            || cur_token.getType() == TokenType.CHAR ||
    cur_token.getToken().equals("(") ) {
                stack.push("condition2");
                stack.push("exp");
            }
            else
                ERROR.syntaxError(cur_token);
        }
        //8-
        public void condition2(){
            if(cur_token.getToken().equals(")"))
                Epsilon();
            else if(cur_token .getToken().equals("<")  ||
                    cur_token .getToken().equals(">")  ||
                    cur_token .getToken().equals("!=")  ||
                    cur_token .getToken().equals("<=") ||
                    cur_token .getToken().equals(">=") ||
                    cur_token .getToken().equals("==") )
            {
                stack.push("exp");
                stack.push("comp_sign");
            }
            else
                ERROR.syntaxError(cur_token);

        }
        //9-
        public void comp_sign(){
            if(cur_token.getToken().equals("<"))
                stack.push("<");
            else if (cur_token.getToken().equals(">"))
                stack.push(">");
            else if (cur_token.getToken().equals("!="))
                stack.push("!=");
            else if (cur_token.getToken().equals("<="))
                stack.push("<=");
            else if (cur_token.getToken().equals(">="))
                stack.push(">=");
            else if (cur_token.getToken().equals("=="))
                stack.push("==");
            else
                ERROR.syntaxError(cur_token);
        }
        //10-
        public void exp() {
            if (cur_token.getType() == TokenType.IDENTIFIER
                    || cur_token.getToken().equals("(")
                    || cur_token.getType() == TokenType.INTEGER
                    || cur_token.getType() == TokenType.FLOAT
                    || cur_token.getType() == TokenType.CHAR) {
                stack.push("exp2");
                stack.push("term");
            }
            else
                ERROR.syntaxError(cur_token);
        }
        //11-
        public void exp2(){
            if(cur_token.getToken().equals("+") | cur_token.getToken().equals("-")) {
                stack.push("exp2");
                stack.push("term");
                stack.push("add_op");
            }
            else if(cur_token.getToken().equals(")") ||
                    cur_token.getToken().equals("<") ||
                    cur_token.getToken().equals(">") ||
                    cur_token.getToken().equals("!=") ||
                    cur_token.getToken().equals("<=")||
                    cur_token.getToken().equals(">=")||
                    cur_token.getToken().equals("==")||
                    cur_token.getToken().equals(";")) {
                Epsilon();
            }
            else
                ERROR.syntaxError(cur_token);
        }
        //12-
        public void add_op(){
            if(cur_token.getToken().equals("+"))
                stack.push("+");
            else if(cur_token.getToken().equals("-"))
                stack.push("-");
            else
                ERROR.syntaxError(cur_token);
        }
        //13-
        public void term(){
            if(cur_token.getToken().equals("(") ||
               cur_token.getType() == TokenType.INTEGER ||
               cur_token.getType() == TokenType.FLOAT ||
               cur_token.getType() == TokenType.CHAR ||
               cur_token.getType() == TokenType.IDENTIFIER) {
                stack.push("term2");
                stack.push("factor");
            }
            else
                ERROR.syntaxError(cur_token);
        }
        //14-
        public void term2(){
            if(cur_token.getToken().equals("*") || cur_token.getToken().equals("/")){
                stack.push("term2");
                stack.push("factor");
                stack.push("mul_op");
            } else if(cur_token.getToken().equals("<")||
                    cur_token.getToken().equals(">")||
                    cur_token.getToken().equals("!=")||
                    cur_token.getToken().equals("<=")||
                    cur_token.getToken().equals(">=")||
                    cur_token.getToken().equals("==")||
                    cur_token.getToken().equals(";")||
                    cur_token.getToken().equals("+")||
                    cur_token.getToken().equals(")")||
                    cur_token.getToken().equals("-"))
                Epsilon();

            else
                ERROR.syntaxError(cur_token);
        }
        //15-
        public void mul_op(){
            if(cur_token.getToken().equals("*"))
```

```
            stack.push("*");
        else if(cur_token.getToken().equals("/"))
            stack.push("/");
        else
            ERROR.syntaxError(cur_token);
    }
    //16-
    public void factor(){
        if (cur_token.getToken().equals("(")){
            stack.push(")");
            stack.push("exp");
            stack.push("(");
        }
        else if(cur_token.getType() == TokenType.IDENTIFIER)
            stack.push("id");
        else if(cur_token.getType() == TokenType.CHAR ||
                cur_token.getType() == TokenType.INTEGER ||
                cur_token.getType() == TokenType.FLOAT) {
            stack.push("value");
        }
        else
            ERROR.syntaxError(cur_token);
    }
    //17-
    public void declare_stmt(){
        if(cur_token.getType() == TokenType.DATATYPE) {
            stack.push(";");
            stack.push("x_stmt");
            stack.push("id");
            stack.push("datatype");
        }
        else
            ERROR.syntaxError(cur_token);
    }
    //18-
    public void x_stmt(){
        if(cur_token.getToken().equals("=")){
            stack.push("exp");
            stack.push("=");
        }
        else if(cur_token.getToken().equals(";"))
            Epsilon();
        else
            ERROR.syntaxError(cur_token);
    }
    //19-
    public void assign_stmt(){
        if(cur_token.getType() == TokenType.IDENTIFIER) {
            stack.push(";");
            stack.push("exp");
            stack.push("=");
            stack.push("id");
        }
        else
            ERROR.syntaxError(cur_token);
    }
    //20-
    public void datatype(){
        if(cur_token.getToken().equals("int"))
            stack.push("int");
        else if(cur_token.getToken().equals("float"))
            stack.push("float");
        else if(cur_token.getToken().equals("char"))
```

```
            stack.push("char");
        else
            ERROR.syntaxError(cur_token);
    }

    /**
     * check if the identifier is exist or not
     */
    private boolean checkIdentifier(Token token){
        if(dictionary.get(token.getToken()) == null)
           return false;
        return true;
    }

    private void putNewIdentifier(String id, String datatype, Token token){
        if(!checkIdentifier(token)){
            dictionary.put(id, datatype);
        }
        else
            ERROR.definedError(token);
    }
    /**
     * just function to do nothing
     */
    public void Epsilon(){
    }
}
```

9- Error Class

```
10- package Parser;
    import Scanner.*;
    import sun.security.krb5.internal.PAData;

    public abstract class ERROR {
        // syntax error that's generated from the parser or bnf grammar
        public static void syntaxError(Token token){
            if(Parser.expecting.length() > 2 )
            {
                if(Parser.expecting.equals("stmt_seq2"))
                    Parser.expecting = "}";
                else if (Parser.expecting.equals("else_part"))
                    Parser.expecting = "if or variable or datatype or }";
                else if (Parser.expecting.equals("condition2"))
                    Parser.expecting = ")";
                else if (Parser.expecting.equals("exp2"))
                    Parser.expecting = ") or comparision sign or ;";
                else if (Parser.expecting.equals("term2"))
                    Parser.expecting = ") or comparision sign or ; or + or -";
                else if (Parser.expecting.equals("x_stmt"))
                    Parser.expecting = ";";
            }
            if(Parser.expecting.equals("id"))
                Parser.expecting = "variable";
            throw new IllegalStateException("Could not parse line " + token.getLine()
    + " at "+
                    "\"" + token.getToken() + "\"" + ", expected " + Parser.expecting
    + " (syntax error)");
        }

        // if the identifier is not defined before and user is using it.
        public static void notDefinedError(Token token){
            throw new IllegalStateException("Could not parse line " + token.getLine()
    +", \"" + token.getToken() + "\"" + " is not defined");
        }

        // if the identifier is already exist in the memory(dictionary) and user is
    declaring it again.
        public static void definedError(Token token){
            throw new IllegalStateException("Could not parse line " + token.getLine()
    +", \"" + token.getToken() + "\"" + " is already defined");
        }

    }
```

Source code files used for testing

1- Test case1

```
int main(){
    int x = 10;
    float y = 5.5;
    x = y + ((5 * 10)-(5-6 * 8) / 2) - 3;
    if(x > y){
        if((x + y) == 0){
            x = 1;
        }else {
            x = 0;
        }
    }else{
        y = x;
    }
}
```

2- Test case2

```
int main(){
    int x = 5;
    int y = 6;
    if(5 + 6{
        x = 5 + 7;
    }
}
```

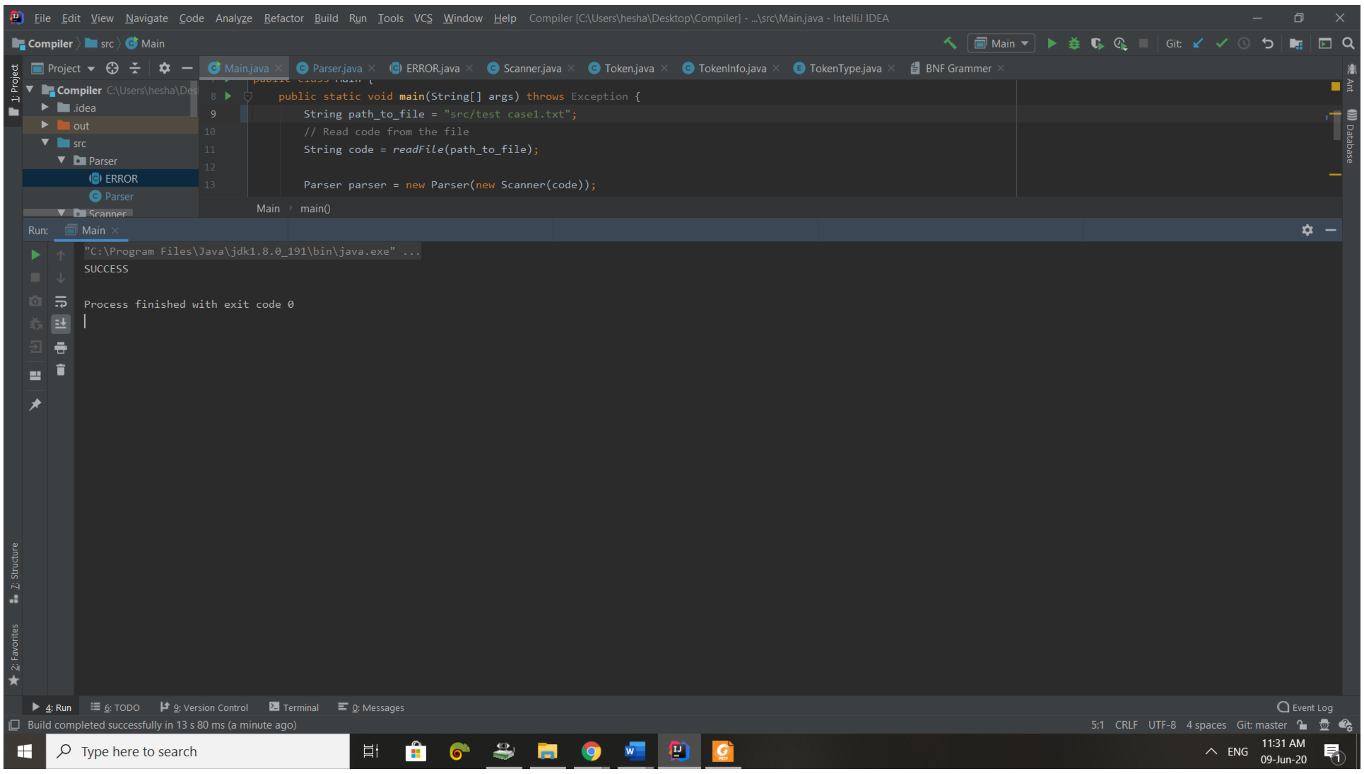
3- Test case3

```
int main(){
    int x = 5;
    int x = 20;
}
```

4. Project output results

– Screenshots of Scanner and Parser output(success/error)

1- Test Case1

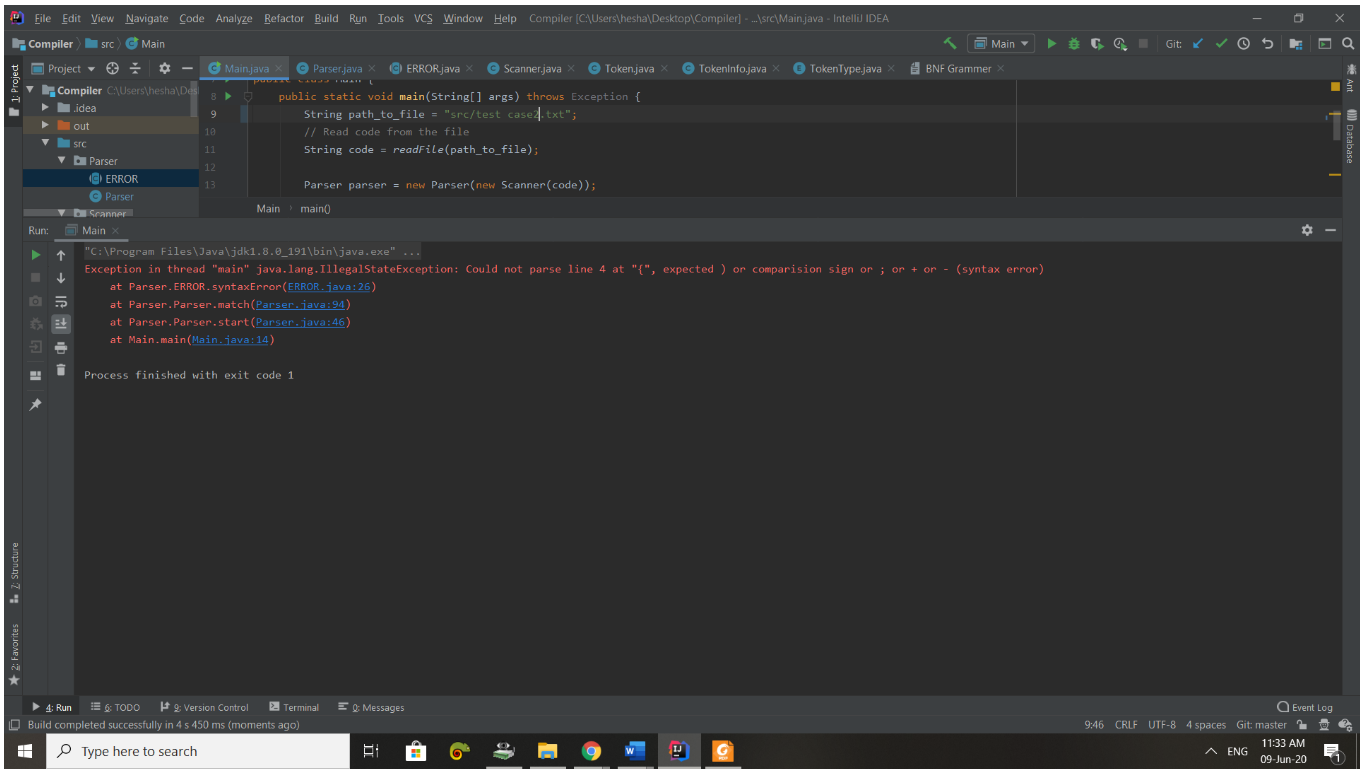


```
public static void main(String[] args) throws Exception {
    String path_to_file = "src/test case1.txt";
    // Read code from the file
    String code = readFile(path_to_file);

    Parser parser = new Parser(new Scanner(code));
```

```
"C:\Program Files\Java\jdk1.8.0_191\bin\java.exe" ...
SUCCESS

Process finished with exit code 0
```

Build completed successfully in 13 s 80 ms (a minute ago)

2- Test Case2

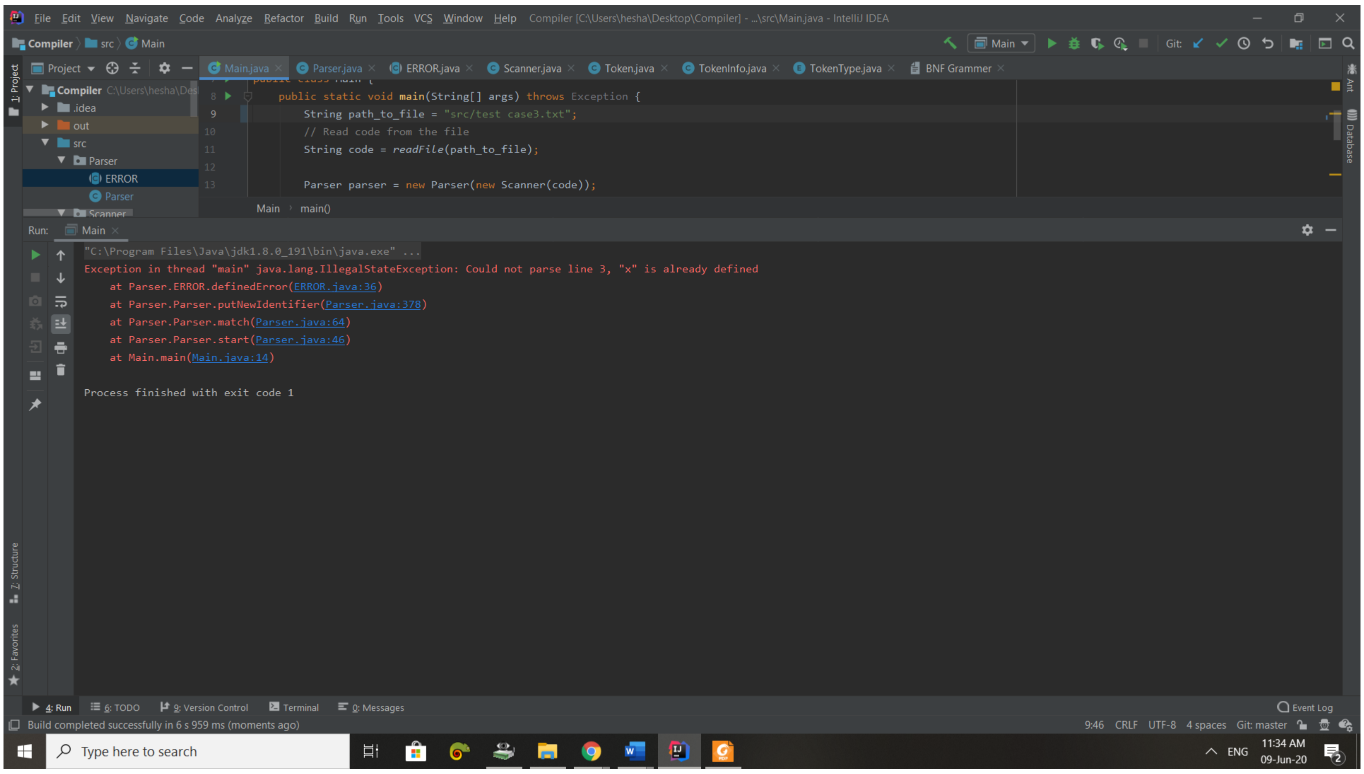


```
public static void main(String[] args) throws Exception {
    String path_to_file = "src/test case2.txt";
    // Read code from the file
    String code = readFile(path_to_file);

    Parser parser = new Parser(new Scanner(code));
```

```
"C:\Program Files\Java\jdk1.8.0_191\bin\java.exe" ...
Exception in thread "main" java.lang.IllegalStateException: Could not parse line 4 at "{", expected ) or comparision sign or ; or + or - (syntax error)
    at Parser.ERROR.syntaxError(ERROR.java:26)
    at Parser.Parser.match(Parser.java:94)
    at Parser.Parser.start(Parser.java:46)
    at Main.main(Main.java:14)

Process finished with exit code 1
```

Build completed successfully in 4 s 450 ms (moments ago)

3- Test Case3



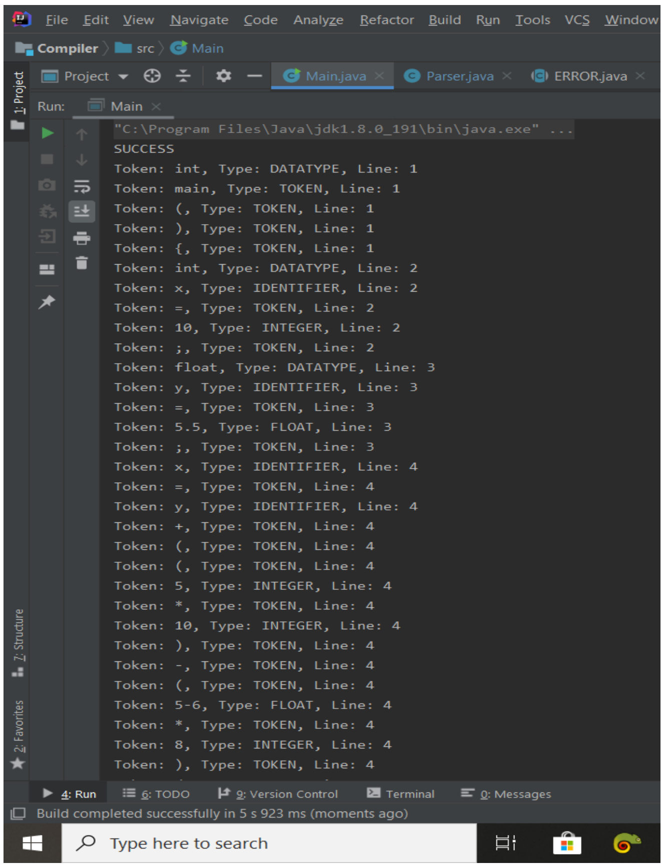
```
    public static void main(String[] args) throws Exception {
        String path_to_file = "src/test case3.txt";
        // Read code from the file
        String code = readFile(path_to_file);

        Parser parser = new Parser(new Scanner(code));
```

```
"C:\Program Files\Java\jdk1.8.0_191\bin\java.exe" ...
Exception in thread "main" java.lang.IllegalStateException: Could not parse line 3, "x" is already defined
    at Parser.ERROR.definedError(ERROR.java:36)
    at Parser.Parser.putNewIdentifier(Parser.java:378)
    at Parser.Parser.match(Parser.java:64)
    at Parser.Parser.start(Parser.java:46)
    at Main.main(Main.java:14)

Process finished with exit code 1
```

Build completed successfully in 6 s 959 ms (moments ago)

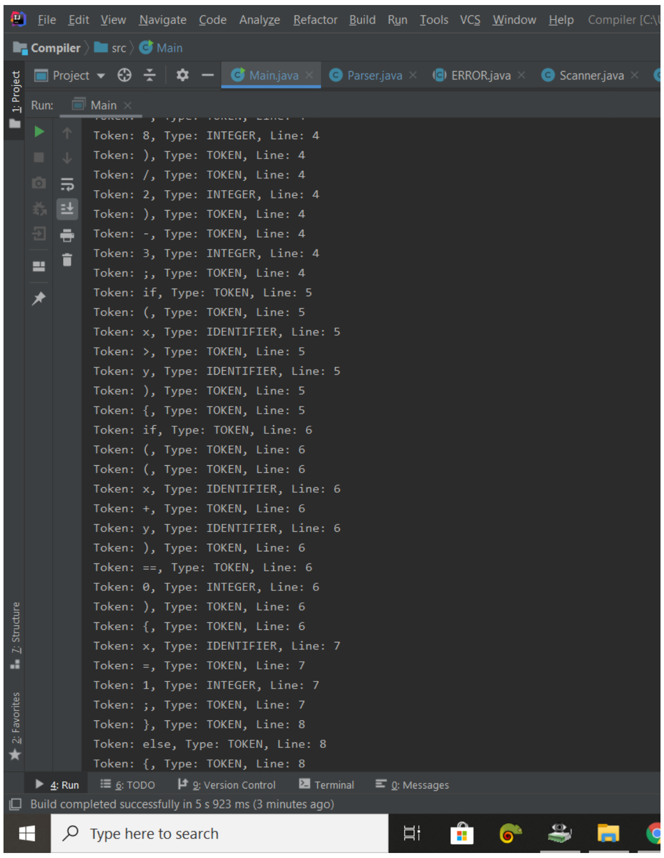
Resulting tokens

1- Test Case1



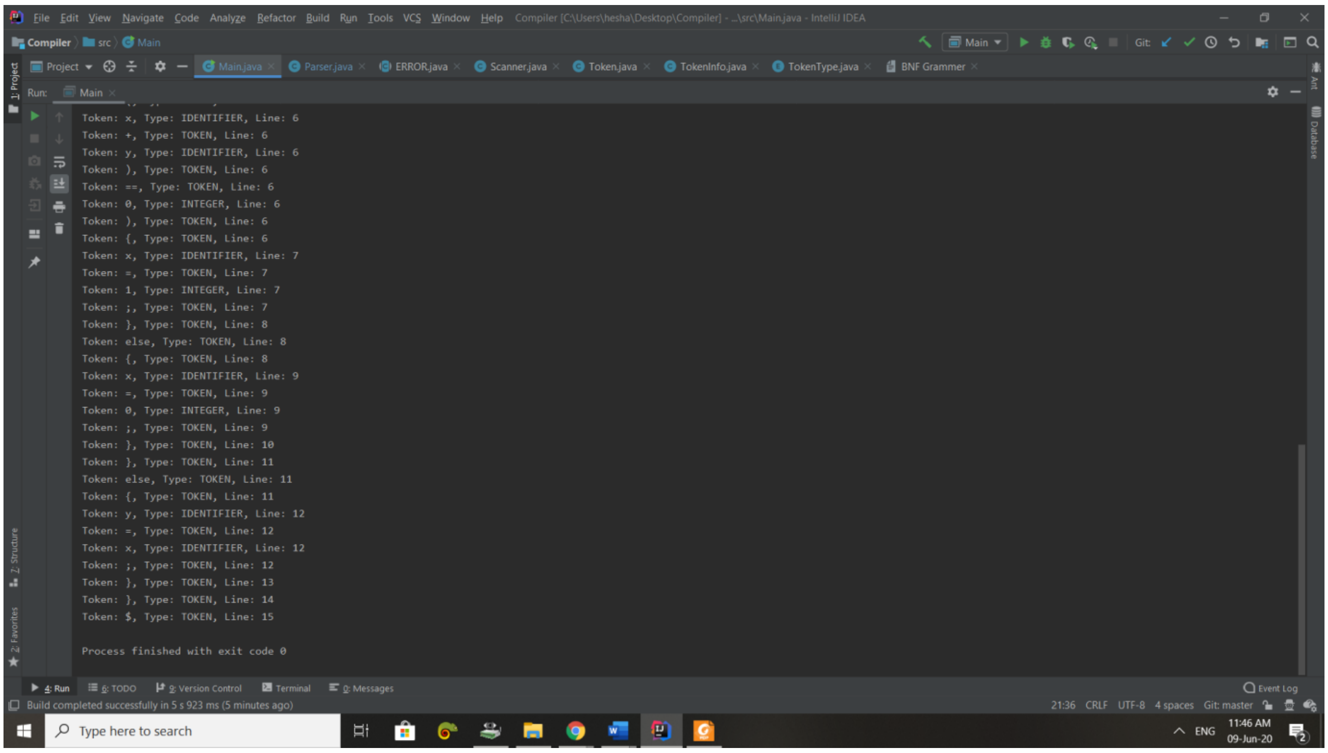
```
"C:\Program Files\Java\jdk1.8.0_191\bin\java.exe" ...
SUCCESS
Token: int, Type: DATATYPE, Line: 1
Token: main, Type: TOKEN, Line: 1
Token: (, Type: TOKEN, Line: 1
Token: ), Type: TOKEN, Line: 1
Token: {, Type: TOKEN, Line: 1
Token: int, Type: DATATYPE, Line: 2
Token: x, Type: IDENTIFIER, Line: 2
Token: =, Type: TOKEN, Line: 2
Token: 10, Type: INTEGER, Line: 2
Token: ;, Type: TOKEN, Line: 2
Token: float, Type: DATATYPE, Line: 3
Token: y, Type: IDENTIFIER, Line: 3
Token: =, Type: TOKEN, Line: 3
Token: 5.5, Type: FLOAT, Line: 3
Token: ;, Type: TOKEN, Line: 3
Token: x, Type: IDENTIFIER, Line: 4
Token: =, Type: TOKEN, Line: 4
Token: y, Type: IDENTIFIER, Line: 4
Token: +, Type: TOKEN, Line: 4
Token: (, Type: TOKEN, Line: 4
Token: (, Type: TOKEN, Line: 4
Token: 5, Type: INTEGER, Line: 4
Token: *, Type: TOKEN, Line: 4
Token: 10, Type: INTEGER, Line: 4
Token: ), Type: TOKEN, Line: 4
Token: -, Type: TOKEN, Line: 4
Token: (, Type: TOKEN, Line: 4
Token: 5-6, Type: FLOAT, Line: 4
Token: *, Type: TOKEN, Line: 4
Token: 8, Type: INTEGER, Line: 4
Token: ), Type: TOKEN, Line: 4
```

Build completed successfully in 5 s 923 ms (moments ago)



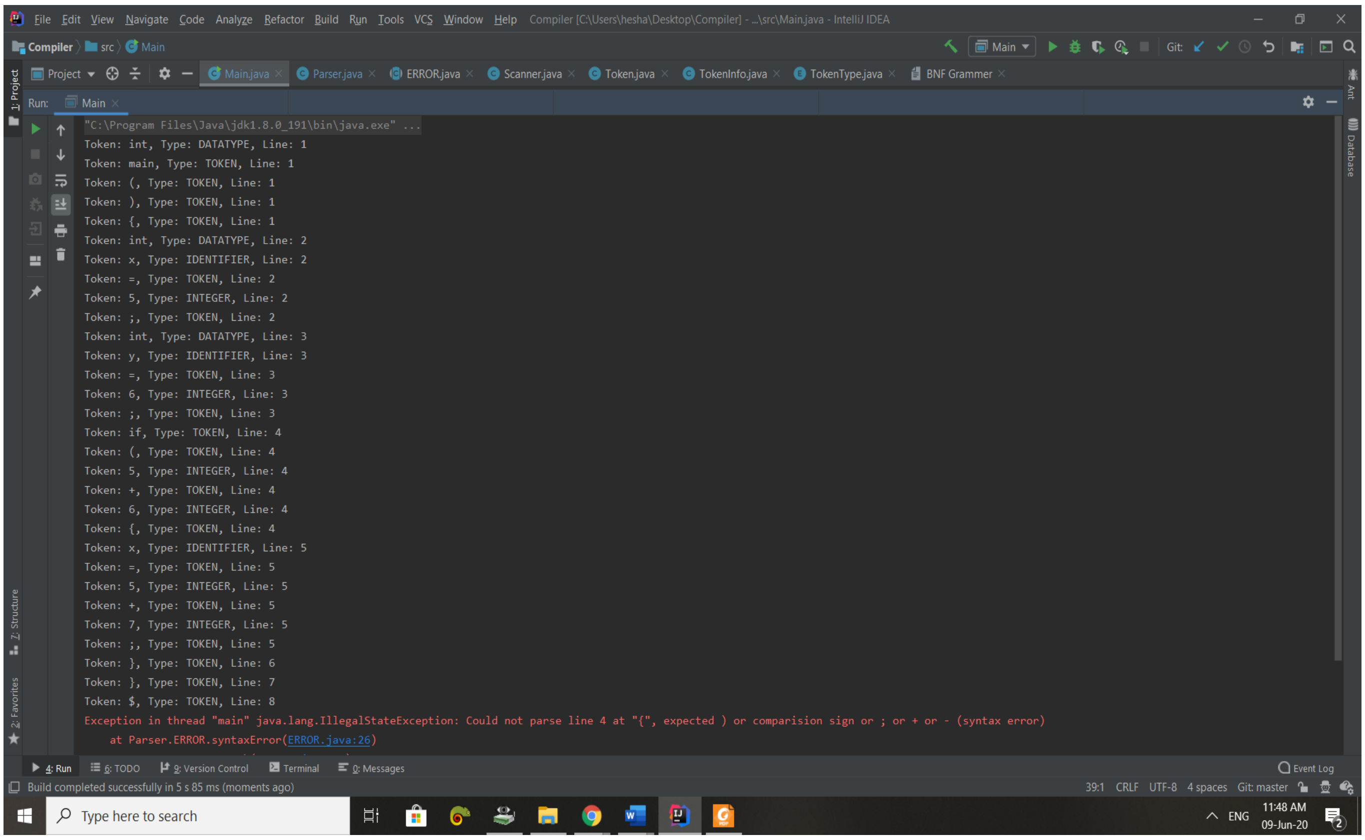
```
Token: 8, Type: INTEGER, Line: 4
Token: ), Type: TOKEN, Line: 4
Token: /, Type: TOKEN, Line: 4
Token: 2, Type: INTEGER, Line: 4
Token: ), Type: TOKEN, Line: 4
Token: -, Type: TOKEN, Line: 4
Token: 3, Type: INTEGER, Line: 4
Token: ;, Type: TOKEN, Line: 4
Token: if, Type: TOKEN, Line: 5
Token: (, Type: TOKEN, Line: 5
Token: x, Type: IDENTIFIER, Line: 5
Token: >, Type: TOKEN, Line: 5
Token: y, Type: IDENTIFIER, Line: 5
Token: ), Type: TOKEN, Line: 5
Token: {, Type: TOKEN, Line: 5
Token: if, Type: TOKEN, Line: 6
Token: (, Type: TOKEN, Line: 6
Token: (, Type: TOKEN, Line: 6
Token: x, Type: IDENTIFIER, Line: 6
Token: +, Type: TOKEN, Line: 6
Token: y, Type: IDENTIFIER, Line: 6
Token: ), Type: TOKEN, Line: 6
Token: ==, Type: TOKEN, Line: 6
Token: 0, Type: INTEGER, Line: 6
Token: ), Type: TOKEN, Line: 6
Token: {, Type: TOKEN, Line: 6
Token: x, Type: IDENTIFIER, Line: 7
Token: =, Type: TOKEN, Line: 7
Token: 1, Type: INTEGER, Line: 7
Token: ;, Type: TOKEN, Line: 7
Token: }, Type: TOKEN, Line: 8
Token: else, Type: TOKEN, Line: 8
Token: {, Type: TOKEN, Line: 8
```

Build completed successfully in 5 s 923 ms (3 minutes ago)



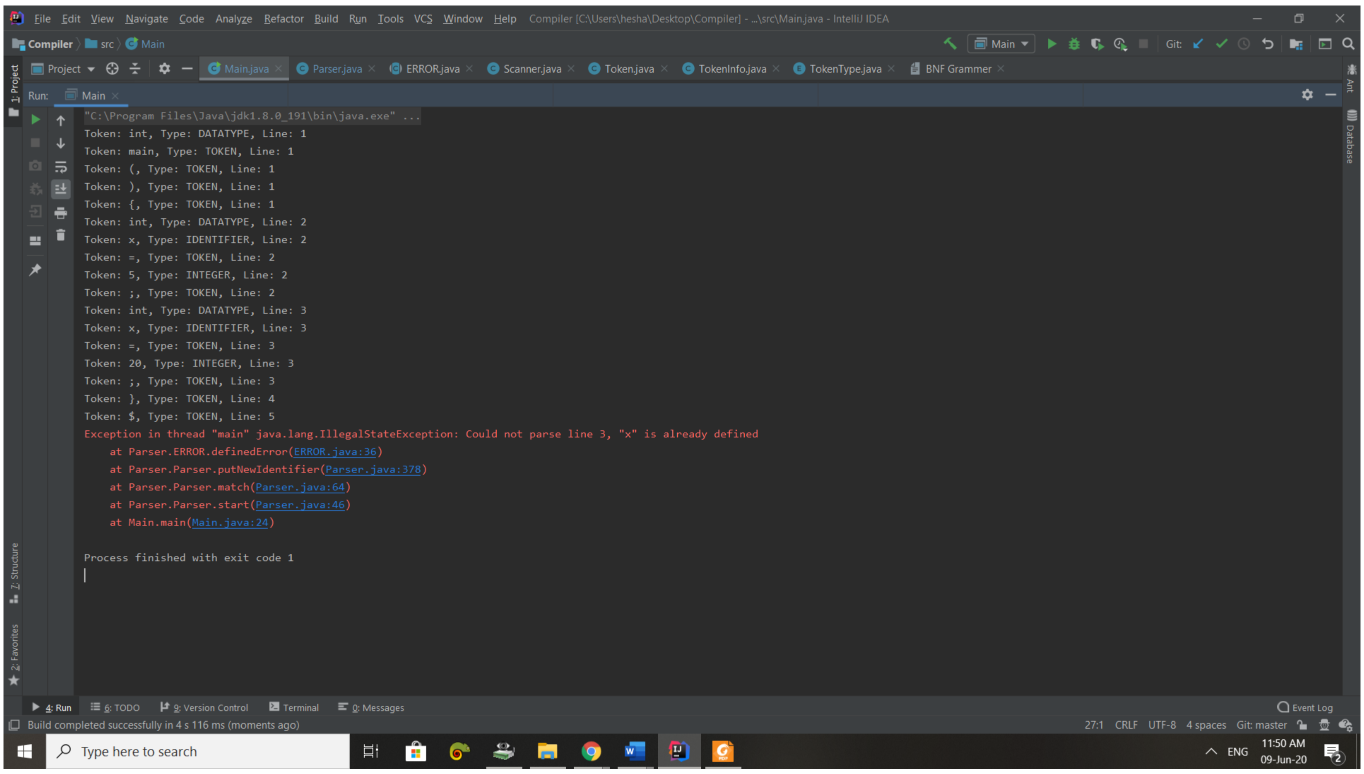
```
Token: x, Type: IDENTIFIER, Line: 6
Token: +, Type: TOKEN, Line: 6
Token: y, Type: IDENTIFIER, Line: 6
Token: ), Type: TOKEN, Line: 6
Token: ==, Type: TOKEN, Line: 6
Token: 0, Type: INTEGER, Line: 6
Token: ), Type: TOKEN, Line: 6
Token: {, Type: TOKEN, Line: 6
Token: x, Type: IDENTIFIER, Line: 7
Token: =, Type: TOKEN, Line: 7
Token: 1, Type: INTEGER, Line: 7
Token: ;, Type: TOKEN, Line: 7
Token: }, Type: TOKEN, Line: 8
Token: else, Type: TOKEN, Line: 8
Token: {, Type: TOKEN, Line: 8
Token: x, Type: IDENTIFIER, Line: 9
Token: =, Type: TOKEN, Line: 9
Token: 0, Type: INTEGER, Line: 9
Token: ;, Type: TOKEN, Line: 9
Token: }, Type: TOKEN, Line: 10
Token: }, Type: TOKEN, Line: 11
Token: else, Type: TOKEN, Line: 11
Token: {, Type: TOKEN, Line: 11
Token: y, Type: IDENTIFIER, Line: 12
Token: =, Type: TOKEN, Line: 12
Token: x, Type: IDENTIFIER, Line: 12
Token: ;, Type: TOKEN, Line: 12
Token: }, Type: TOKEN, Line: 13
Token: }, Type: TOKEN, Line: 14
Token: $, Type: TOKEN, Line: 15

Process finished with exit code 0
```

2- Test Case2



```
"C:\Program Files\Java\jdk1.8.0_191\bin\java.exe" ...
Token: int, Type: DATATYPE, Line: 1
Token: main, Type: TOKEN, Line: 1
Token: (, Type: TOKEN, Line: 1
Token: ), Type: TOKEN, Line: 1
Token: {, Type: TOKEN, Line: 1
Token: int, Type: DATATYPE, Line: 2
Token: x, Type: IDENTIFIER, Line: 2
Token: =, Type: TOKEN, Line: 2
Token: 5, Type: INTEGER, Line: 2
Token: ;, Type: TOKEN, Line: 2
Token: int, Type: DATATYPE, Line: 3
Token: y, Type: IDENTIFIER, Line: 3
Token: =, Type: TOKEN, Line: 3
Token: 6, Type: INTEGER, Line: 3
Token: ;, Type: TOKEN, Line: 3
Token: if, Type: TOKEN, Line: 4
Token: (, Type: TOKEN, Line: 4
Token: 5, Type: INTEGER, Line: 4
Token: +, Type: TOKEN, Line: 4
Token: 6, Type: INTEGER, Line: 4
Token: {, Type: TOKEN, Line: 4
Token: x, Type: IDENTIFIER, Line: 5
Token: =, Type: TOKEN, Line: 5
Token: 5, Type: INTEGER, Line: 5
Token: +, Type: TOKEN, Line: 5
Token: 7, Type: INTEGER, Line: 5
Token: ;, Type: TOKEN, Line: 5
Token: }, Type: TOKEN, Line: 6
Token: }, Type: TOKEN, Line: 7
Token: $, Type: TOKEN, Line: 8
Exception in thread "main" java.lang.IllegalStateException: Could not parse line 4 at "{", expected ) or comparision sign or ; or + or - (syntax error)
    at Parser.ERROR.syntaxError(ERROR.java:26)
```

3- Test Case3



```
"C:\Program Files\Java\jdk1.8.0_191\bin\java.exe" ...
Token: int, Type: DATATYPE, Line: 1
Token: main, Type: TOKEN, Line: 1
Token: (, Type: TOKEN, Line: 1
Token: ), Type: TOKEN, Line: 1
Token: {, Type: TOKEN, Line: 1
Token: int, Type: DATATYPE, Line: 2
Token: x, Type: IDENTIFIER, Line: 2
Token: =, Type: TOKEN, Line: 2
Token: 5, Type: INTEGER, Line: 2
Token: ;, Type: TOKEN, Line: 2
Token: int, Type: DATATYPE, Line: 3
Token: x, Type: IDENTIFIER, Line: 3
Token: =, Type: TOKEN, Line: 3
Token: 20, Type: INTEGER, Line: 3
Token: ;, Type: TOKEN, Line: 3
Token: }, Type: TOKEN, Line: 4
Token: $, Type: TOKEN, Line: 5
Exception in thread "main" java.lang.IllegalStateException: Could not parse line 3, "x" is already defined
    at Parser.ERROR.definedError(ERROR.java:36)
    at Parser.Parser.putNewIdentifier(Parser.java:378)
    at Parser.Parser.match(Parser.java:64)
    at Parser.Parser.start(Parser.java:46)
    at Main.main(Main.java:24)

Process finished with exit code 1
```

Build completed successfully in 4 s 116 ms (moments ago)

5. Grammar

The grammar written in BNF notation.

```
// note 3 = epsilon or nothing
1- program -> stmt_seq

2- stmt_seq -> stmt stmt_seq'

3- stmt_seq' -> stmt_seq | 3

4- stmt -> if_stmt | assign_stmt ; | declare_stmt ;

5- if_stmt -> if ( condition ) { stmt_seq' } else_part

6- else_part -> else { stmt_seq' } | 3

7- condition -> exp condition'

8- condition' -> comp_sign exp | 3

9- comp_sign ->  < | > | == | >= | <= | !=

10- exp -> term exp'

11- exp' -> add_op term exp' | 3

12- add_op -> + | -

13- term -> factor term'

14- term'-> mul_op factor term' | 3

15- mul_op -> * | /

16- factor -> ( exp ) | value | id

17- declare_stmt -> datatype id x_stmt

18- x_stmt -> = exp | 3

19- assign_stmt -> id = exp

20- datatype-> int | float | char
```

6. Parsing method used

Start():

It’s the point of parser to start working, where I prepare the stack and then loop over the stack until it get empty and with every loop I call function match.

Match():

This is where the program decides what non-terminal to release or terminal to match (pop form stack and get next token) according to the current token and top of the stack, if the current token is not matching with the top then the function is using the top (string) as a name of the function to call instead of creating if-else to determine what is the appropriate function to use, where I named all the functions as names of non-terminals.

You see this line, I use string as the name of the function to call.

```
Parser.class.getMethod(stack.pop()).invoke(this);
```

Then, there are 20 functions each function is releasing a specific non-terminal in the stack according to ll1 parser table and BNF grammar.

If there is a token which not matching with the current top of the stack and also after releasing all possible non-terminals then that’s an error in the code.

Epsilon();

Function to do nothing, just to simulate the parser table.

7. First and Follow sets

Grammar	First	Follow
`1- program -> stmt_seq`	If, id, int, float, char	$
`2- stmt_seq -> stmt stmt_seq'`	If, id, int, float, char	$,}
`3- stmt_seq' -> stmt_seq | 3`	if, id, int, float, char, 3	$, }
`4- stmt -> if_stmt | assign_stmt ; | declare_stmt ;`	If, id, int, float, char	if, id, int, float, char, $,}
`5- if_stmt -> if ( condition ) { stmt_seq' } else_part`	If	if, id, int, float, char, $,}
`6- else_part -> else { stmt_seq' } | 3`	else, 3	if, id, int, float, char, $,}
`7- condition -> exp condition'`	(, value, id	)
`8- condition' -> comp_sign exp | 3`	<, >, ==, >=, <=, !=, 3	)
`9- comp_sign ->  < | > | == | >= | <= | !=`	<, >, ==, >=, <=, !=	(, value, id
`10- exp -> term exp'`	(, value, id	<, >, ==, >=, <=, !=,), ;
`11- exp' -> add_op term exp' | 3`	+, -, 3	<, >, ==, >=, <=, !=,), ;
`12- add_op -> + | -`	+, -	(, value, id
`13- term -> factor term'`	(, value, id	+, -, <, >, ==, >=, <=, !=,), ;
`14- term' -> mul_op factor term' | 3`	*, /, 3	+, -, <, >, ==, >=, <=, !=,), ;
`15- mul_op -> * | /`	*, /	(, value, id
`16- factor -> ( exp ) | value | id`	(, value, id	*, /, +, -, <, >, ==, >=, <=, !=,), ;
`17- declare_stmt -> datatype id x`	Int, float, char	;
`18- x_stmt -> = exp | 3`	=, 3	;
`19- assign_stmt -> id = exp`	Id	;
`20- datatype-> int | float | char`	Int, float, char	id

8. ll1 parse table

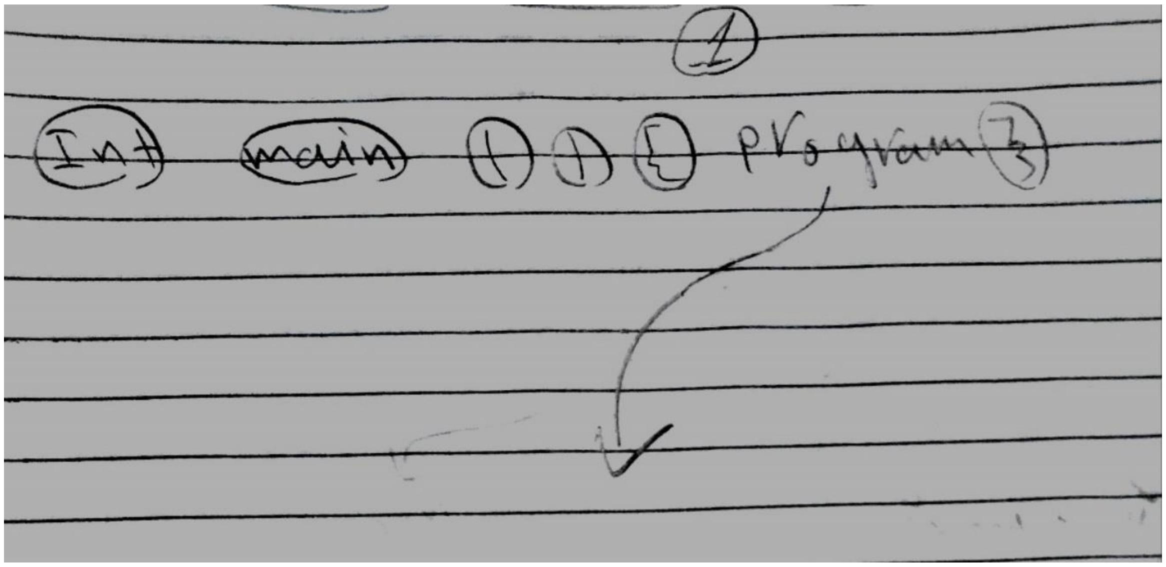
line	If	Id	Int	Float	Char	Else	(	)	<	>	=	!=	<=	>=	==	;	value	*	/	+	-	}	$
1-	1	1	1	1	1																		
2-	2	2	2	2	2																		
3-	Stmt_seq’->stmt_seq	Stmt_seq’->stmt_seq	Stmt_seq’->stmt_seq	Stmt_seq’->stmt_seq	Stmt_seq’->stmt_seq																	Stmt_seq’->3	Stmt_seq’->3
4-	Stmt-> if_stmt	stmt->assign_stmt ;	Stmt->declare_stmt ;	Stmt->declare_stmt ;	Stmt->declare_stmt ;																		
5-	5																						
6-	else_part->3	else_part->3	else_part->3	else_part->3	else_part->3	else_part->else{ stmt_seq’ }																else_part->3	else_part->3
7-		7					7										7						
8-								Condition’->3	condition’->comp_sign exp	condition’->comp_sign exp		condition’->comp_sign exp	condition’->comp_sign exp	condition’->comp_sign exp	condition’->comp_sign exp								
9-									comp_sign-> <	comp_sign-> >		comp_sign-> !=	comp_sign-> <=	comp_sign-> >=	comp_sign-> ==								
10-		10					10										10						

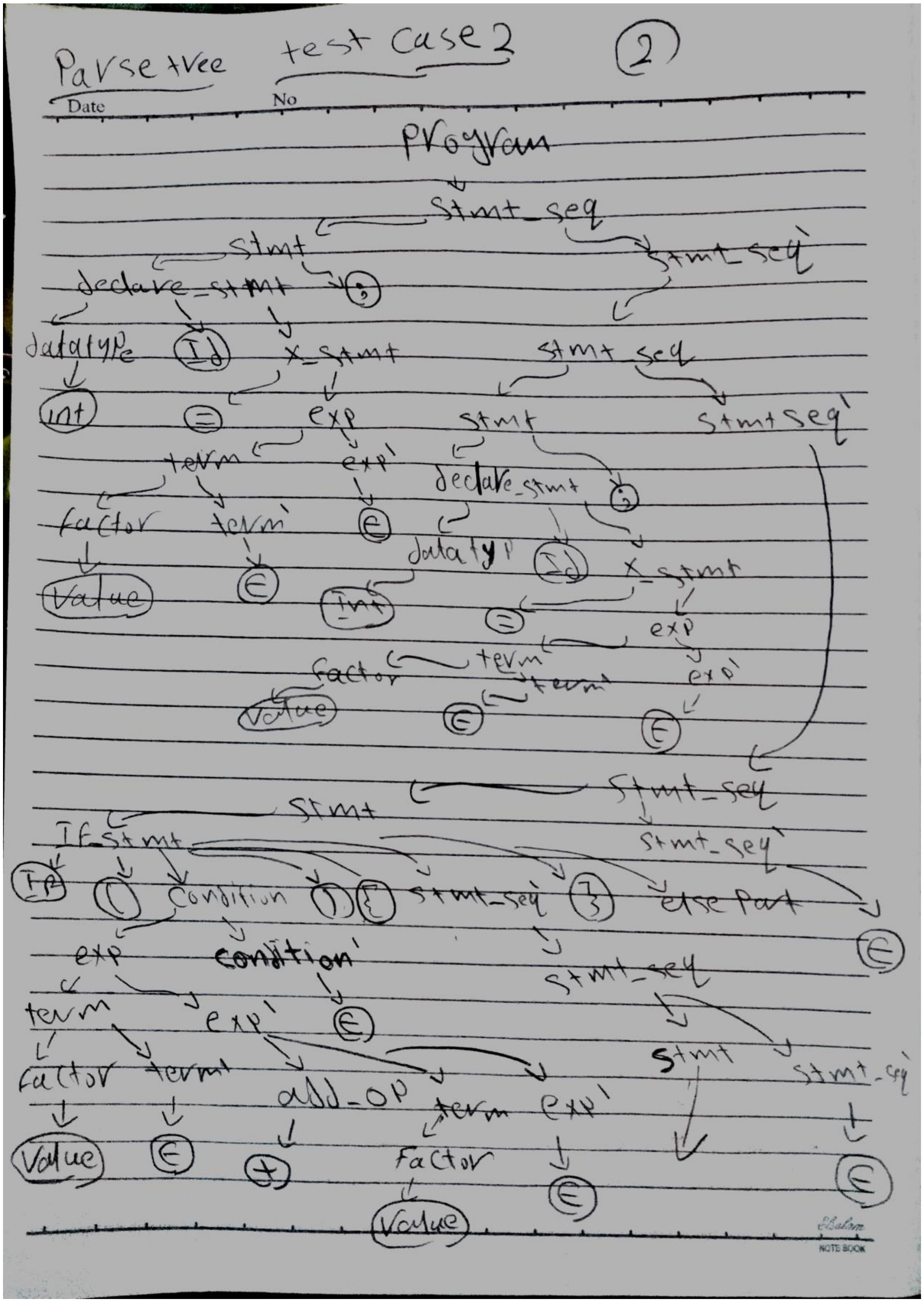
	If	id	int	float	char	else	(	)	<	>	=	!=	<=	>=	==	;	value	*	/	+	-	}	$
11 -								exp’-> 3	exp’-> 3	exp’-> 3		exp’-> 3	exp’-> 3	exp’-> 3	exp’-> 3	exp’-> 3				exp’->add_op term exp’	exp’->add_op term exp’		
12 -																				add_op -> +	add_op -> -		
13 -		13					13										13						
14 -								Term’->3	Term’->3	Term’->3		Term’->3	Term’->3	Term’->3	Term’->3	Term’ ->3		Term->mul_op factor term’	Term->mul_op factor term’	Term’->3	Term’->3		
15 -																		mul_op ->*	mul_op ->/				
16 -		Factor->id					Factor->(exp)										Factor->value						
17 -			17	17	17																		
18 -											x_stmt-> = exp					x_stmt-> 3							
19 -		19																					
20			datatype->int	Datatype->float	datatype->char																		

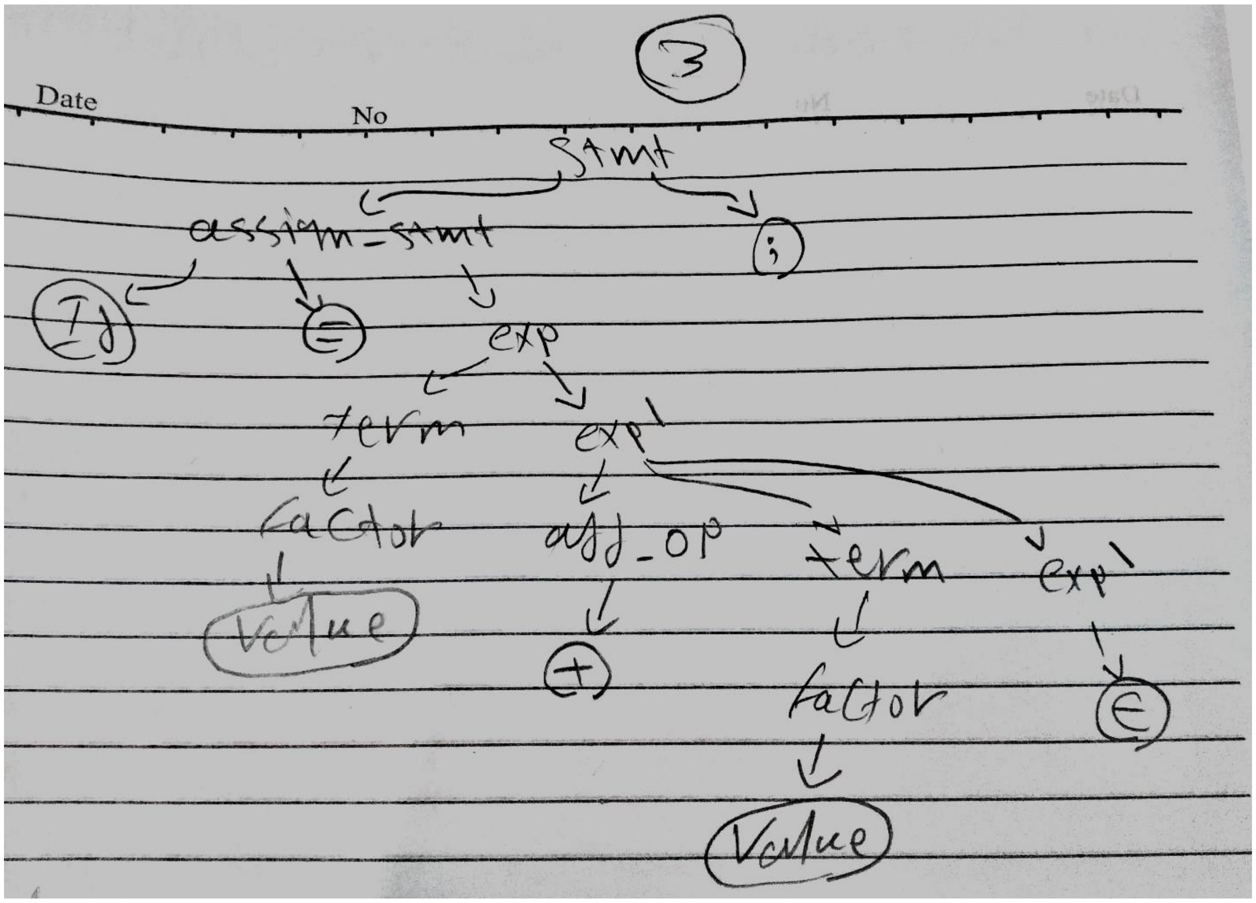
9. Parse Tree

Parse tree for Test Case2, but with fixing the error,

```
int main(){
    int x = 5;
    int y = 6;
    if(5 + 6){
            x = 5 + 7;
    }
}
```




Parse tree test case 2
2
Date
No
Program
Stmt_seq
stmt
Stmt_seq'
declare_stmt
;
Stmt_seq
datatype
Id
x_stmt
int
=
exp
stmt
Stmt seq'
term
exp'
declare_stmt
;
factor
term'
E
datatyp
Id
x_stmt
Value
E
Int
=
exp
factor
term
exp'
Value
term'
E
E
Stmt_seq
Stmt
stmt_seq'
If_stmt
If
(
condition
)
{
stmt_seq
}
else Part
E
exp
condition'
stmt_seq
term
exp'
E
stmt
stmt_seq'
factor
term'
add_op
term
exp'
Value
E
+
Factor
E
E
Value
NOTE BOOK


3
Date
No
stmt
assign_stmt
;
Id
=
exp
term
exp'
factor
add_op
term
exp'
value
+
factor
ϵ
value

10. Role of each group member

Member	Task
Mahmoud Tarek Mohamed	**Scanner**
Mahmoud Salah Gad	**Error handling and BNF grammar**
Hesham Ahmed Hassan	**Parser and ll1 parse table**

11. References

1- https://www.youtube.com/watch?v=R1ZlWEZWMKk&fbclid=IwAR3RWT3vHYTddlQn69RN60tBmoVw-qKNxrYTZdOI2Qy93aSwJoJSz6b7VYg

2- **compiler-construction-principles-and-practice book**

3- **Slides**

4- https://www.youtube.com/watch?v=nCiluoENyOg&list=PLQkyODvJ8ywuGxYwN0BfMSvembIJkNQH1&index=40