**2023학년도 1학기 [프로그래밍언어론]**

**Lab05 과제 보고서**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 제출일 | 6월 8일 | 분반 | 002 | 학과 | 소프트웨어학부  컴퓨터과학전공 |
| 학번 | 2016133 | 이름 | 이유진 | | |

1. 구현한 프로그램에 대한 설명

1) Language S에 함수 관련 기능 추가 구현

- EBNF 문법

<command> -> … | <function>

<function> -> fun <type> id ( <params> ) <stmt>

<params> -> <type> id {, <type> id}

…

<stmt> -> … | return <expr> | id(<expr> {, <expr>});

<factor> -> … | id(<expr> {, <expr>});

- 함수 정의, 함수 호출, 리턴문

2) 타입 검사 구현: 함수 정의 (TypeChecker.java)

2. 실행 결과 캡처 사진

1) hi8.s

텍스트, 스크린샷, 소프트웨어, 멀티미디어 소프트웨어이(가) 표시된 사진

자동 생성된 설명

2) hi9.s

텍스트, 스크린샷, 소프트웨어, 멀티미디어 소프트웨어이(가) 표시된 사진

자동 생성된 설명

3) hi10.s

텍스트, 스크린샷, 소프트웨어, 멀티미디어 소프트웨어이(가) 표시된 사진

자동 생성된 설명

4) hi11.s

텍스트, 스크린샷, 폰트, 소프트웨어이(가) 표시된 사진

자동 생성된 설명

5) hi12.s

텍스트, 스크린샷, 폰트, 소프트웨어이(가) 표시된 사진

자동 생성된 설명

6) hi13.s

텍스트, 스크린샷, 소프트웨어, 폰트이(가) 표시된 사진

자동 생성된 설명

3. 프로그램 소스 코드 (복사-붙여넣기)

1) AST.java

// AST.java

// AST for S

// 프로그래밍언어론 lab05 소프트웨어학부 컴퓨터과학전공 2016133 이유진

import java.util.\*;

class Indent {

public static void display(int level, String s) {

String tab = "";

System.***out***.println();

for (int i = 0; i < level; i++)

tab = tab + " ";

System.***out***.print(tab + s);

}

}

abstract class Command {

// Command = Decl | Function | Stmt

Type type = Type.***UNDEF***;

public void display(int l) {

Indent.*display*(l,getClass().toString().substring(6));

}

}

class Decls extends ArrayList<Decl> { //done

// Decls = Decl\*

public ArrayList<Decl> ds = new ArrayList<Decl>();

Decls() { super(); }; //?

Decls(Decl d) { //?

this.add(d);

}

public void display(int level) {

Indent.*display*(level,"Decls");

for (Decl decl:this)

decl.display(level+1);

}

}

class Decl extends Command { //done

// Decl = Type type; Identifier id

Identifier id;

Expr expr = null;

int arraysize = 0;

Decl (String s, Type t) {

id = new Identifier(s); type = t;

} // declaration

Decl (String s, Type t, int n) { //lab04 이용

id = new Identifier(s); type = t; arraysize = n;

} // array declaration

Decl (String s, Type t, Expr e) {

id = new Identifier(s); type = t; expr = e;

} // declaration

public void display(int level){

super.display(level);

type.display(level+1);

id.display(level+1);

if (expr != null )

expr.display(level+1);

}

public String toString ( ) { //lab04 done?

return id + " " + expr;

}

}

class Functions extends ArrayList<Function> { //lab05

// Functions = Function\*

}

class Function extends Command { //lab05 함수 정의

// Function = Type type; Identifier id; Decls params; Stmt stmt

Identifier id;

Decls params;

Stmt stmt;

Function(String s, Type t) {

id = new Identifier(s); type = t; params = null; stmt = null;

}

public String toString ( ) {

return id.toString() + params.toString();

// return id.toString(); //?

}

}

class Type {

// Type = int | bool | string | fun | array | except | void

final static Type ***INT*** = new Type("int");

final static Type ***BOOL*** = new Type("bool");

final static Type ***STRING*** = new Type("string");

final static Type ***VOID*** = new Type("void");

final static Type ***FUN*** = new Type("fun");

final static Type ***ARRAY*** = new Type("array");

final static Type ***EXC*** = new Type("exc"); //?

final static Type ***RAISEDEXC*** = new Type("raisedexc"); //?

final static Type ***UNDEF*** = new Type("undef");

final static Type ***ERROR*** = new Type("error");

protected String id;

protected Type(String s) { id = s; }

public String toString ( ) { return id; }

public void display(int level){ //done

Indent.*display*(level,"Type: " + id);

}

}

class ProtoType extends Type {

// defines the type of a function and its parameters

Type result;

Decls params;

ProtoType (Type t, Decls ds) {

super(t.id);

result = t;

params = ds;

}

}

abstract class Stmt extends Command {//ektl

// Stmt = Empty | Stmts | Assignment | If | While | Let | Read | Print

public void display(int l) {

// Indent.display(l,getClass().toString().substring(6)+"");

super.display(l);

}

}

class Empty extends Stmt { //done

public void display(int level){

super.display(level);

}

}

class Stmts extends Stmt {//ektl

// Stmts = Stmt\*

public ArrayList<Stmt> stmts = new ArrayList<Stmt>();

// Stmts() { super(); }

// Stmts(Stmt s) {

// stmts.add(s);

// }

// Stmts(Stmt s, While w){ //lab03 done

// stmts.add(s);

// stmts.add(w);

// }

// Stmts(Stmt s, Assignment a){ //lab03 done

// stmts.add(s);

// stmts.add(a);

// }

//

// public void display(int level){ //done

// Indent.display(level,"Stmts");

// for (Stmt s:stmts){

// if (s!=null)

// s.display(level+1);

// }

//

// }

Stmt s;

While w = null;

Stmts ss = null;

Assignment a = null;

Stmts() { super(); }

Stmts(Stmt s,While w) {

this.w = w; this.s = s;

}

Stmts(While w){

this.w = w;

}

Stmts(Stmt s, Assignment a){

this.s = s; this.a = a;

}

public void display(int level){

Indent.*display*(level,"Stmts");

if (s != null)

s.display(level+1);

if (w != null)

w.display(level+1);

if (ss != null)

ss.display(level+1);

for (Stmt s : stmts){

if (s != null)

s.display(level+1);

}

if (a != null)

a.display(level+1);

}

}

class Assignment extends Stmt {//

// Assignment = Identifier id; Expr expr

Identifier id;

Array ar = null; //?

Expr expr;

Assignment (Identifier t, Expr e) {

id = t;

expr = e;

}

Assignment (Array a, Expr e) { //lab04 이용

//id[<expr>] = <expr>;

ar = a;

expr = e;

}

public String toString(){ //lab04 done?

return ar.id + " " + ar.expr + " " + id + " " + expr;

}

public void display(int level) { //lab04 done?

// Indent.display(level, "Assignment");

// id.display(level+1);

// ar.display(level+1); //lab04 추가

// expr.display(level+1);

super.display(level);

if (id != null)

id.display(level+1);

expr.display(level+1);

if (ar != null)

ar.display(level+1);

}

}

class If extends Stmt {//

// If = Expr expr; Stmt stmt1, stmt2;

Expr expr;

Stmt stmt1, stmt2;

If (Expr t, Stmt tp) {

expr = t; stmt1 = tp; stmt2 = new Empty( );

}

If (Expr t, Stmt tp, Stmt ep) {

expr = t; stmt1 = tp; stmt2 = ep;

}

public void display(int level){

super.display(level);

expr.display(level+1);

stmt1.display(level+1);

stmt2.display(level+1);

}

}

class While extends Stmt { //lab04 수정 필요

// While = Expr expr; Stmt stmt;

// Expr expr;

// Stmt stmt;

//

// While (Expr t, Stmt b) {

// expr = t; stmt = b;

// }

// public void display(int level){ //done

// super.display(level);

// expr.display(level+1);

// stmt.display(level+1);

// }

Expr expr = null;

Stmt stmt, stmts;

Stmt stmt1 = null;

While (Expr t, Stmt b) {

expr = t; stmt = b;

}

While (Expr t, Stmt b,Stmt a) {

expr = t; stmt = b; stmt1 = a;

}

public String toString(){

return expr + " " + stmt;

}

public void display(int level){

Indent.*display*(level, "While: ");

if (stmt1 != null)

stmt1.display(level+1);

expr.display(level+1);

if (stmt != null)

stmt.display(level+1);

if (stmts != null)

stmts.display(level+1);

}

}

class Let extends Stmt { //lab04 수정 필요

// Let = Decls decls; Functions funs; Stmts stmts;

// Decls decls;

// Functions funs;

// Stmts stmts;

//

// Let(Decls ds, Stmts ss) {

// decls = ds;

// funs = null;

// stmts = ss;

// }

// Let(Decls ds, Functions fs, Stmts ss) {

// decls = ds;

// funs = fs;

// stmts = ss;

// }

//

// public void display(int level){ //done

// super.display(level);

// decls.display(level+1);

// stmts.display(level+1);

// }

Decls decls;

Functions funs;

While wh;

Stmts stmts;

Assignment asm;

Let(Decls ds, Functions fs, Stmts ss) {

decls = ds;

funs = fs;

stmts = ss;

}

public String toString(){

return decls + " " + stmts;

}

public void display(int level){

super.display(level);

decls.display(level+1);

if (stmts != null)

stmts.display(level+1);

if (wh != null)

wh.display(level+1);

if (asm != null)

asm.display(level+1);

}

}

class Read extends Stmt { //done

// Read = Identifier id

Identifier id;

Read (Identifier v) {

id = v;

}

public void display(int level){

super.display(level);

id.display(level+1);

}

}

class Print extends Stmt {

// Print = Expr expr

Expr expr;

Print (Expr e) {

expr = e;

}

public String toString(){ //lab04 done?

return expr + " ";

}

public void display(int level){

super.display(level);

expr.display(level+1);

}

}

class Return extends Stmt { //lab05 이용 : 리턴문

Identifier fid;

Expr expr;

Return (String s, Expr e) {

fid = new Identifier(s);

expr = e;

}

public void display(int level){

super.display(level);

fid.display(level+1);

expr.display(level+1);

}

}

class Try extends Stmt {

// Try = Identifier id; Stmt stmt1; Stmt stmt2;

Identifier eid;

Stmt stmt1;

Stmt stmt2;

Try(Identifier id, Stmt s1, Stmt s2) {

eid = id;

stmt1 = s1;

stmt2 = s2;

}

}

class Raise extends Stmt {

Identifier eid;

Raise(Identifier id) {

eid = id;

}

}

class Exprs extends ArrayList<Expr> {

// Exprs = Expr\*

public ArrayList<Expr> exprs = new ArrayList<Expr>();

public void display(int level) {

for (Expr e : exprs){

if (e != null)

e.display(level+1);

}

}

}

abstract class Expr extends Stmt {

// Expr = Identifier | Value | Binary | Unary | Call

public void display(int l) {

Indent.*display*(l, getClass().toString().substring(6)+":");

}

}

class Call extends Expr { //lab05 이용 : 함수 호출

Identifier fid;

Exprs args;

Call(Identifier id, Exprs a) {

fid = id;

args = a;

}

public void display(int level){

super.display(level);

fid.display(level+1);

args.display(level+1);

}

}

class Identifier extends Expr {

// Identifier = String id

private String id;

Identifier(String s) { id = s; }

public String toString( ) { return id; }

public boolean equals (Object obj) {

String s = ((Identifier) obj).id;

return id.equals(s);

}

public void display(int level){

Indent.*display*(level, "Identifier: "+id);

}

}

class Array extends Expr { //lab04 이용

// Array = Identifier id; Expr expr;

// id[<expr>] : 배얼 요소 접근, 즉 배열[인덱스]에 대한 표현

Identifier id;

Expr expr = null;

Array(Identifier s, Expr e) { id = s; expr = e; }

public String toString( ) { return id.toString(); }

public boolean equals (Object obj) {

String s = ((Array) obj).id.toString();

return id.equals(s);

}

public void display(int level) {

if (id!=null)

id.display(level+1);

if (expr!=null)

expr.display(level+1);

// Indent.display(level, "Array");

System.***out***.print(": " + id);

}

}

class Value extends Expr { //lab04 이용

// Value = int | bool | string | array | function

protected boolean undef = true;

Object value = null; // Type type;

Expr e; //lab04 done?

Value v;

Value(Type t) {

type = t;

if (type == Type.***INT***) value = new ~~Integer~~(0);

if (type == Type.***BOOL***) value = new ~~Boolean~~(false);

if (type == Type.***STRING***) value = "";

undef = false;

}

Value(Object v) {

if (v instanceof Integer) type = Type.***INT***;

if (v instanceof Boolean) type = Type.***BOOL***;

if (v instanceof String) type = Type.***STRING***;

if (v instanceof Function) type = Type.***FUN***;

if (v instanceof Value[]) type = Type.***ARRAY***;

if (v instanceof Function) type = Type.***FUN***; //lab05 추가

value = v; undef = false;

}

Value(Expr e, Value v){

this.e = e; this.v = v;

} //lab04?

Object value() { return value; }

int intValue( ) {

if (value instanceof Integer)

return ((Integer) value).intValue();

else return 0;

}

boolean boolValue( ) {

if (value instanceof Boolean)

return ((Boolean) value).booleanValue();

else return false;

}

String stringValue ( ) {

if (value instanceof String)

return (String) value;

else return ""; //null

}

Function funValue ( ) { //lab05 이용

if (value instanceof Function)

return (Function) value;

else return null;

}

Value[] arrValue ( ) { //lab04 이용

if (value instanceof Value[])

return (Value[]) value;

else return null;

}

Type type ( ) { return type; }

public String toString( ) { //done

//if (undef) return "undef";

if (type == Type.***INT***) return "" + intValue();

if (type == Type.***BOOL***) return "" + boolValue();

if (type == Type.***STRING***) return "" + stringValue();

if (type == Type.***FUN***) return "" + funValue();

if (type == Type.***ARRAY***) return "" + arrValue(); //?

return "undef";

}

public void display(int level){

Indent.*display*(level,"Value: " + value);

}

}

class Binary extends Expr {//

// Binary = Operator op; Expr expr1; Expr expr2;

Operator op;

Expr expr1, expr2;

Binary (Operator o, Expr e1, Expr e2) {

op = o; expr1 = e1; expr2 = e2;

} // binary

public String toString(){ //lab04 done?

return op + " " + expr1 + " " + expr2;

}

public void display(int level) {

Indent.*display*(level, "Binary");

op.display(level+1);

expr1.display(level+1);

expr2.display(level+1);

}

}

class Unary extends Expr { //done

// Unary = Operator op; Expr expr

Operator op;

Expr expr;

Unary (Operator o, Expr e) {

op = o; //(o.val == "-") ? new Operator("neg"): o;

expr = e;

} // unary

public void display(int level){

super.display(level);

op.display(level+1);

if (expr != null)

expr.display(level+1);

}

}

class Operator { //done

String val;

Operator (String s) {

val = s;

}

public String toString( ) {

return val;

}

public boolean equals(Object obj) {

return val.equals(obj);

}

public void display(int level){

Indent.*display*(level, "Operator: " + val);

}

}

//AST.java

2) Parser.java

// Parser.java

// Parser for language S

// 프로그래밍언어론 lab05 소프트웨어학부 컴퓨터과학전공 2016133 이유진

public class Parser {

*Token* token; // current token

Lexer lexer;

String funId = "";

public Parser(Lexer scan) {

lexer = scan;

token = lexer.getToken(); // get the first token

}

private String match(*Token* t) {

String value = token.value();

if (token == t)

token = lexer.getToken();

else

error(t);

return value;

}

private void error(*Token* tok) {

System.***err***.println("Syntax error: " + tok + " --> " + token);

token = lexer.getToken();

}

private void error(String tok) {

System.***err***.println("Syntax error: " + tok + " --> " + token);

token = lexer.getToken();

}

public Command command() {

// <command> -> <decl> | <function> | <stmt>

if (isType()) {

Decl d = decl();

return d;

}

/\*

if (token == Token.FUN) {

Function f = function();

return f;

}

\*/

if (token != *Token*.***EOF***) {

Stmt s = stmt();

return s;

}

return null;

}

private Decl decl() {

// <decl> -> <type> id[n]; //lab04

// <decl> -> <type> id [=<expr>];

Type t = type();

String id = match(*Token*.***ID***);

Decl d = null;

if (token == *Token*.***LBRACKET***) { //lab04 done

match(*Token*.***LBRACKET***);

int n = Integer.*parseInt*(match(*Token*.***NUMBER***));

match(*Token*.***RBRACKET***);

match(*Token*.***SEMICOLON***);

return new Decl(id, t, n);

}

if (token == *Token*.***ASSIGN***) {

match(*Token*.***ASSIGN***);

Expr e = expr();

d = new Decl(id, t, e);

}

else

d = new Decl(id, t);

match(*Token*.***SEMICOLON***);

return d;

}

private Decls decls () {

// <decls> -> {<decl>}

Decls ds = new Decls ();

while (isType()) {

Decl d = decl();

ds.add(d);

}

return ds;

}

private Function function() { //lab05

// <function> -> fun <type> id(<params>) <stmt>

match(*Token*.***FUN***);

Type t = type();

String str = match(*Token*.***ID***);

funId = str;

Function f = new Function(str, t);

match(*Token*.***LPAREN***);

if (token != *Token*.***RPAREN***)

f.params = params();

match(*Token*.***RPAREN***);

Stmt s = stmt();

f.stmt = s;

return f;

}

private Decls params() { //lab05

// <params> -> <type> id {, <type> id}

Decls params = new Decls();

// parse declrations of parameters

return params;

}

private Type type () {

// <type> -> int | bool | void | string

Type t = null;

switch (token) {

case ***INT***:

t = Type.***INT***; break;

case ***BOOL***:

t = Type.***BOOL***; break;

case ***VOID***:

t = Type.***VOID***; break;

case ***STRING***:

t = Type.***STRING***; break;

default:

error("int | bool | void | string");

}

match(token);

return t;

}

private Stmt stmt() {

// <stmt> -> <block> | <assignment> | <ifStmt> | <whileStmt> | ...

Stmt s = new Empty();

switch (token) {

case ***SEMICOLON***:

match(*Token*.***SEMICOLON***); return s;

case ***LBRACE***:

match(*Token*.***LBRACE***);

s = stmts();

match(*Token*.***RBRACE***);

return s;

case ***IF***: // if statement

s = ifStmt(); return s;

case ***WHILE***: // while statement

s = whileStmt(); return s;

case ***ID***: // assignment

s = assignment(); return s;

case ***LET***: // let statement

s = letStmt(); return s;

case ***READ***: // read statement

s = readStmt(); return s;

case ***PRINT***: // print statment

s = printStmt(); return s;

case ***RETURN***: // return statement

s = returnStmt(); return s;

case ***DO***: //lab03 done

s = dowhileStmt(); return s;

case ***FOR***: //lab03 done

s = forStmt(); return s;

default:

error("Illegal stmt"); return null;

}

}

private Stmts stmts () {

// <block> -> {<stmt>}

Stmts ss = new Stmts();

while((token != *Token*.***RBRACE***) && (token != *Token*.***END***))

ss.stmts.add(stmt());

return ss;

}

private Let letStmt () {

// <letStmt> -> let <decls> in <block> end

match(*Token*.***LET***);

Decls ds = decls();

match(*Token*.***IN***);

Stmts ss = stmts();

match(*Token*.***END***);

match(*Token*.***SEMICOLON***);

return new Let(ds, null, ss);

}

private Read readStmt() { //done

// <readStmt> -> read id;

match(*Token*.***READ***);

Identifier id = new Identifier(match(*Token*.***ID***));

match(*Token*.***SEMICOLON***);

return new Read(id);

}

private Print printStmt() { //done

// <printStmt> -> print <expr>;

match(*Token*.***PRINT***);

Expr e = expr();

match(*Token*.***SEMICOLON***);

return new Print(e);

}

private Return returnStmt() { //lab05 함수 리턴

// <returnStmt> -> return <expr>;

match(*Token*.***RETURN***);

Expr e = expr();

match(*Token*.***SEMICOLON***);

return new Return(funId, e);

}

private Stmt assignment() {

// <assignment> -> id[<expr>] = <expr>; //lab04

// <assignment> -> id = <expr>;

Array array = null;

Expr e1 = null;

Expr e2 = null;

Identifier id = new Identifier(match(*Token*.***ID***));

if (token == *Token*.***LPAREN***) // lab05 function call

return call(id);

while (token == *Token*.***LBRACKET***) {

match(*Token*.***LBRACKET***);

e1 = expr();

match(*Token*.***RBRACKET***);

array = new Array(id, e1);

}

if (token == *Token*.***ASSIGN***){

match(*Token*.***ASSIGN***);

e2 = expr();

match(*Token*.***SEMICOLON***);

}

if (array == null)

return new Assignment(id, e2);

else

return new Assignment(array, e2);

}

private Call call(Identifier id) { //lab05 함수 호출

// <call> -> id(<expr>{,<expr>});

// parse function call

match(*Token*.***LPAREN***);

Call c = new Call(id, arguments());

match(*Token*.***RPAREN***);

match(*Token*.***SEMICOLON***);

return c;

//return null;

}

private If ifStmt () {

// <ifStmt> -> if (<expr>) then <stmt> [else <stmt>]

match(*Token*.***IF***);

match(*Token*.***LPAREN***);

Expr e = expr();

match(*Token*.***RPAREN***);

match(*Token*.***THEN***);

Stmt s1 = stmt();

Stmt s2 = new Empty();

if (token == *Token*.***ELSE***){

match(*Token*.***ELSE***);

s2 = stmt();

}

return new If(e, s1, s2);

}

private While whileStmt () { //done

// <whileStmt> -> while (<expr>) <stmt>

match(*Token*.***WHILE***);

match(*Token*.***LPAREN***);

Expr e = expr();

match(*Token*.***RPAREN***);

Stmt s = stmt();

return new While(e, s);

}

private Stmts dowhileStmt() { //lab03 done

// <dowhileStmt> -> do <stmt> while (<expr>);

match(*Token*.***DO***);

Stmt s = stmt();

match(*Token*.***WHILE***);

match(*Token*.***LPAREN***);

Expr e = expr();

match(*Token*.***RPAREN***);

match(*Token*.***SEMICOLON***);

While w = new While(e, s);

return new Stmts(s, w);

}

private Let forStmt() { //lab03 done

// <forStmts> -> for(<type> id = <expr>; <expr>; id=<expr>) <stmt>

match(*Token*.***FOR***);

match(*Token*.***LPAREN***);

Decls ds = decls();

Expr e1 = expr();

match(*Token*.***SEMICOLON***);

Identifier id = new Identifier(match(*Token*.***ID***));

match(*Token*.***ASSIGN***);

Expr e2 = expr();

match(*Token*.***RPAREN***);

Stmt s = stmt();

Assignment a = new Assignment(id, e2);

Stmts wss = new Stmts(s, a);

While w = new While(e1, wss);

Stmts ss = new Stmts(w);

return new Let(ds, null, ss);

}

private Expr expr () { //done

// <expr> -> <bexp> {& <bexp> | '|'<bexp>} | !<expr> | true | false

switch (token) {

case ***NOT***:

Operator op = new Operator(match(token));

Expr e = expr();

return new Unary(op, e);

case ***TRUE***:

match(*Token*.***TRUE***);

return new Value(true);

case ***FALSE***:

match(*Token*.***FALSE***);

return new Value(false);

}

Expr e = bexp();

Expr b = null;

Operator op = null;

while (token == *Token*.***AND*** || token == *Token*.***OR***){

op = new Operator(match(token));

b = bexp();

return new Binary(op, e, b);

}

return e;

}

private Expr bexp() { //done

// <bexp> -> <aexp> [ (< | <= | > | >= | == | !=) <aexp> ]

Expr e = aexp();

Expr a = null;

Operator op = null;

switch (token) {

case ***LT***:

op = new Operator(match(token));

a = aexp();

return new Binary(op, e, a);

case ***LTEQ***:

op = new Operator(match(token));

a = aexp();

return new Binary(op, e, a);

case ***GT***:

op = new Operator(match(token));

a = aexp();

return new Binary(op, e, a);

case ***GTEQ***:

op = new Operator(match(token));

a = aexp();

return new Binary(op, e, a);

case ***EQUAL***:

op = new Operator(match(token));

a = aexp();

return new Binary(op, e, a);

case ***NOTEQ***:

op = new Operator(match(token));

a = aexp();

return new Binary(op, e, a);

}

return e;

}

private Expr aexp () {

// <aexp> -> <term> { + <term> | - <term> }

Expr e = term();

while (token == *Token*.***PLUS*** || token == *Token*.***MINUS***) {

Operator op = new Operator(match(token));

Expr t = term();

e = new Binary(op, e, t);

}

return e;

}

private Expr term () {

// <term> -> <factor> { \* <factor> | / <factor>}

Expr t = factor();

while (token == *Token*.***MULTIPLY*** || token == *Token*.***DIVIDE***) {

Operator op = new Operator(match(token));

Expr f = factor();

t = new Binary(op, t, f);

}

return t;

}

private Expr factor() {

// <factor> -> [-](id | id'['<expr>']' | <call> | literal | '('<aexp> ')')

// lab04

Operator op = null;

if (token == *Token*.***MINUS***)

op = new Operator(match(*Token*.***MINUS***));

Expr e = null;

switch(token) {

case ***ID***:

Identifier v = new Identifier(match(*Token*.***ID***));

// e = v;

// if (token == Token.LPAREN) { // function call

// match(Token.LPAREN);

// Call c = new Call(v,arguments());

// match(Token.RPAREN);

// e = c;

// }

if (token == *Token*.***LBRACKET***){ //lab04 done?

match(*Token*.***LBRACKET***);

Expr n = expr();

match(*Token*.***RBRACKET***);

return new Array(v, n);

}

else

e = v;

break;

case ***NUMBER***: case ***STRLITERAL***:

e = literal();

break;

case ***LPAREN***:

match(*Token*.***LPAREN***);

e = aexp();

match(*Token*.***RPAREN***);

break;

default:

error("Identifier | Literal");

}

if (op != null)

return new Unary(op, e);

else return e;

}

private Exprs arguments() { //?

// arguments -> [ <expr> {, <expr> } ]

Exprs es = new Exprs();

while (token != *Token*.***RPAREN***) {

es.add(expr());

if (token == *Token*.***COMMA***)

match(*Token*.***COMMA***);

else if (token != *Token*.***RPAREN***)

error("Exprs");

}

return es;

}

private Value literal( ) {

String s = null;

switch (token) {

case ***NUMBER***:

s = match(*Token*.***NUMBER***);

return new Value(Integer.*parseInt*(s));

case ***STRLITERAL***:

s = match(*Token*.***STRLITERAL***);

return new Value(s);

}

throw new IllegalArgumentException( "no literal");

}

private boolean isType( ) {

switch(token) {

case ***INT***: case ***BOOL***: case ***STRING***:

return true;

default:

return false;

}

}

public static void main(String args[]) { //

Parser parser;

if (args.length == 0) {

System.***out***.print(">> ");

Lexer.*interactive* = true;

parser = new Parser(new Lexer());

do {

if (parser.token == *Token*.***EOF***)

parser.token = parser.lexer.getToken();

Command command = null;

try {

command = parser.command();

if (command != null)

command.display(0); // display AST

} catch (Exception e) {

System.***err***.println(e);

}

System.***out***.print("\n>> ");

} while(true);

}

else {

System.***out***.println("Begin parsing... " + args[0]);

parser = new Parser(new Lexer(args[0]));

Command command = null;

do {

if (parser.token == *Token*.***EOF***) break;

try {

command = parser.command();

if (command != null)

command.display(0); // display AST

} catch (Exception e) {

System.***err***.println(e);

}

} while (command != null);

}

} //main

} // Parser.java

3) Sint.java

// Sint.java

// Interpreter for S

// 프로그래밍언어론 lab05 소프트웨어학부 컴퓨터과학전공 2016133 이유진

import java.util.Scanner;

public class Sint {

static Scanner *sc* = new Scanner(System.***in***);

static State *state* = new State();

static Value [] *arr*; //lab04

State Eval(Command c, State state) {

//전역 변수 선언; 상태 변환 함수 Eval

if (c instanceof Decl) { //lab05 이용

Decls decls = new Decls();

decls.add((Decl) c);

return allocate(decls, state);

}

if (c instanceof Function) { //lab05 추가

Function f = (Function) c;

state.push(f.id, new Value(f));

return state;

}

if (c instanceof Stmt)

return Eval((Stmt) c, state);

throw new IllegalArgumentException("no command");

}

State Eval(Stmt s, State state) {

if (s instanceof Empty)

return Eval((Empty)s, state);

if (s instanceof Assignment)

return Eval((Assignment)s, state);

if (s instanceof If)

return Eval((If)s, state);

if (s instanceof While)

return Eval((While)s, state);

if (s instanceof Stmts)

return Eval((Stmts)s, state);

if (s instanceof Let)

return Eval((Let)s, state);

if (s instanceof Read)

return Eval((Read)s, state);

if (s instanceof Print)

return Eval((Print)s, state);

if (s instanceof Call)

return Eval((Call)s, state);

if (s instanceof Return)

return Eval((Return)s, state);

throw new IllegalArgumentException("no statement");

}

State Eval(Call c, State state) { //lab05 추가: call without return value

// evaluate call without return value

return state;

}

Value V (Call c, State state) { //lab05 추가: value-returning call

Value v = state.get(c.fid); // find function

Function f = v.funValue();

State s = newFrame(state, c, f); // create new frame on the stack

s = Eval(f.stmt, s); // interpret the call

v = s.peek().val; // get the return value v = s.get(new Identifier("return"));

s = deleteFrame(s, c, f); // delete the frame on the stack

return v;

}

State Eval(Return r, State state) { //lab05 추가: 함수 반환

Value v = V(r.expr, state);

return state.set(new Identifier("return"), v);

}

State newFrame (State state, Call c, Function f) { //lab05 추가

//프레임 구성, 매개변수 전달

if (c.args.size() == 0)

return state;

//인자값 계산 -> 그 값을 val[]에 저장

Value val[] = new Value[f.params.size()];

int i = 0;

for (Expr e: c.args)

val[i++] = V(e, state);

//형식 매개변수들을 위한 기억공간 할당 (allocate 사용)

state.push(new Identifier("return"), null);

//인자값들을 형식 매개변수에 복사

//프레임에 반환값 엔트리를 매개변수 바로 위에 추가

// return null;

return state;

}

State deleteFrame (State state, Call c, Function f) { //lab05 추가

//프레임에 반환값 엔트리 제거

state.pop(); // pop the return value

//프레임에서 매개변수를 위한 기억공간 제거 (free 사용)

// return null;

return state;

}

State Eval(Empty s, State state) { return state; }

State Eval(Assignment a, State state) {

//lab04 수정: id[<expr>] = <expr>; //done

// if (state.lookup(a.id) == -1){

// throw new NullPointerException("variable not defined");

// } else {

// Value v = V(a.expr, state);

// return state.set(a.id, v);

// }

Value v = V(a.expr, state);

if (a.ar == null)

return state.set(a.id,v);

for (int i=0; i<state.size(); i++){

Pair p = state.get(i);

if (a.ar.id.equals(p.id)){

Value va = V(a.ar.expr, state);

*arr*[va.intValue()] = v;

}

}

return state.set(a.ar.id, new Value(*arr*));

}

State Eval(Read r, State state) {

int n = *sc*.nextInt(); //lab03 done

state.set(r.id, new Value(n));

if (r.id.type == Type.***INT***) {

int i = *sc*.nextInt();

state.set(r.id, new Value(i));

}

if (r.id.type == Type.***BOOL***) {

boolean b = *sc*.nextBoolean();

state.set(r.id, new Value(b));

}

// input string

if (r.id.type == Type.***STRING***) { //lab03 done

String str = *sc*.next();

state.set(r.id, new Value(str));

}

return state;

}

State Eval(Print p, State state) {

System.***out***.println(V(p.expr, state));

return state;

}

State Eval(Stmts ss, State state) {

for (Stmt s : ss.stmts) {

state = Eval(s, state);

// if (s instanceof Return) //?

// return state;

}

return state;

}

State Eval(If c, State state) {

if (V(c.expr, state).boolValue( ))

return Eval(c.stmt1, state);

else

return Eval(c.stmt2, state);

}

State Eval(While l, State state) {

if (V(l.expr, state).boolValue( ))

return Eval(l, Eval(l.stmt, state));

else

return state;

}

State Eval(Let l, State state) {

State s = allocate(l.decls, state); //stack에 let~end의 엔트리 쌍을 만들어줌

s = Eval(l.stmts,s);

return free(l.decls, s);

}

State allocate (Decls ds, State state) {//lab03, lab04 수정

//선언된 변수들(ds)을 위한 엔트리들을 상태 state에 추가

Identifier id;

Value v;

if (ds != null) {

// add entries for declared variables on the state

//lab04 수정, <type> id[n];

for (int i=0; i<ds.size(); i++) {

id = ds.get(i).id;

// v = (Value) ds.get(i).expr;

//lab04 ektl

if (ds.get(i).arraysize != 0){ //array

*arr* = new Value[ds.get(i).arraysize]; // 배열 선언에 대해서 배열

state.push(id, new Value(*arr*)); // (id, new Value(배열))을 state에 push

}

else { //not array

v = (Value) ds.get(i).expr;

if (state.lookup(id) != -1)

state = state.push(id, v);

else

state.push(id, v);

// state.push(id,(Value)v);

}

}

}

else

throw new NullPointerException("variable not declared");

return state;

}

State free (Decls ds, State state) {//lab03 done

//선언된 변수들(ds)의 엔트리를 상태 state에서 제거

if (ds != null && !state.isEmpty()) {

// free the entries for declared variables from the state

for (int i=0; i<ds.size(); i++)

state.pop();

}

return state;

}

Value binaryOperation(Operator op, Value v1, Value v2) {

*check*(!v1.undef && !v2.undef,"reference to undef value");

switch (op.val) {

case "+":

return new Value(v1.intValue() + v2.intValue());

case "-":

return new Value(v1.intValue() - v2.intValue());

case "\*":

return new Value(v1.intValue() \* v2.intValue());

case "/":

return new Value(v1.intValue() / v2.intValue());

// relational operations : lab03 done

case "=="://done

if (v1.type==Type.***STRING*** && v2.type==Type.***STRING***)

return new Value(v1.stringValue().equals(v2.stringValue()));

if (v1.type==Type.***INT*** && v2.type==Type.***INT***)

return new Value(v1.intValue() == v2.intValue());

case "!="://done

if (v1.type==Type.***STRING*** && v2.type==Type.***STRING***)

return new Value(!v1.stringValue().equals(v2.stringValue()));

if (v1.type==Type.***INT*** && v2.type==Type.***INT***)

return new Value(v1.intValue() != v2.intValue());

case ">"://done

if (v1.type==Type.***STRING*** && v2.type==Type.***STRING***) {

return new Value(v1.stringValue().compareTo(v2.stringValue()) > 0);

}

if (v1.type==Type.***INT*** && v2.type==Type.***INT***)

return new Value(v1.intValue() > v2.intValue());

return new Value(v1.intValue() > v2.intValue());

case ">="://done

if (v1.type==Type.***STRING*** && v2.type==Type.***STRING***) {

return new Value(v1.stringValue().compareTo(v2.stringValue()) >= 0);

}

if (v1.type==Type.***INT*** && v2.type==Type.***INT***) {

return new Value(v1.intValue() >= v2.intValue());

}

case "<"://done

if (v1.type==Type.***STRING*** && v2.type==Type.***STRING***) {

return new Value(v1.stringValue().compareTo(v2.stringValue()) < 0);

}

if (v1.type==Type.***INT*** && v2.type==Type.***INT***)

return new Value(v1.intValue() < v2.intValue());

return new Value(v1.intValue() < v2.intValue());

case "<="://done

if (v1.type==Type.***STRING*** && v2.type==Type.***STRING***) {

return new Value(v1.stringValue().compareTo(v2.stringValue()) <= 0);

}

if (v1.type==Type.***INT*** && v2.type==Type.***INT***) {

return new Value(v1.intValue() <= v2.intValue());

}

// logical operations : lab03 done

case "&":

return new Value(v1.boolValue() && v2.boolValue());

case "|":

return new Value(v1.boolValue() || v2.boolValue());

default:

throw new IllegalArgumentException("no operation");

}

}

Value unaryOperation(Operator op, Value v) {

*check*(!v.undef, "reference to undef value");

switch (op.val) {

case "!":

return new Value(!v.boolValue( ));

case "-":

return new Value(-v.intValue( ));

default:

throw new IllegalArgumentException("no operation: " + op.val);

}

}

static void check(boolean test, String msg) {

if (test) return;

System.***err***.println(msg);

}

Value V(Expr e, State state) {

if (e instanceof Value)

return (Value) e;

if (e instanceof Identifier) {

Identifier v = (Identifier) e;

return (Value) (state.get(v));

// return state.get(v);

}

if (e instanceof Array) { //lab04 done?

// id[<expr>]

Array ar = (Array) e; //배열 이름이 나타내는 배열에서

Value va = V(ar.expr, state);

return (Value) (*arr*[va.intValue()]); //배열 요소 id[<expr>]의 값

}

if (e instanceof Binary) {

Binary b = (Binary) e;

Value v1 = V(b.expr1, state);

Value v2 = V(b.expr2, state);

return binaryOperation (b.op, v1, v2);

}

if (e instanceof Unary) {

Unary u = (Unary) e;

Value v = V(u.expr, state);

return unaryOperation(u.op, v);

}

if (e instanceof Call)

return V((Call) e, state);

throw new IllegalArgumentException("no operation");

}

public static void main(String args[]) {

if (args.length == 0) {

Sint sint = new Sint();

Lexer.*interactive* = true;

System.***out***.println("Language S Interpreter 2.0");

System.***out***.print(">> ");

Parser parser = new Parser(new Lexer());

do { // Program = Command\*

if (parser.token == *Token*.***EOF***)

parser.token = parser.lexer.getToken();

Command command = null;

try {

command = parser.command();

if (command == null)

throw new Exception();

else {

command.display(0);

/\* command.type = TypeChecker.Check(command);

System.out.println("\nType: "+ command.type);\*/

}

} catch (Exception e) {

System.***out***.println(e);

System.***out***.print(">> ");

continue;

}

if (command.type != Type.***ERROR***) {

System.***out***.println("\nInterpreting..." );

try {

*state* = sint.Eval(command, *state*);

} catch (Exception e) {

System.***err***.println(e);

}

}

System.***out***.print(">> ");

} while (true);

}

else {

System.***out***.println("Begin parsing... " + args[0]);

Command command = null;

Parser parser = new Parser(new Lexer(args[0]));

Sint sint = new Sint();

do { // Program = Command\*

if (parser.token == *Token*.***EOF***) break;

try {

command = parser.command();

if (command == null)

throw new Exception();

else {

// command.display(0);

/\* command.type = TypeChecker.Check(command);

System.out.println("\nType: "+ command.type); \*/

}

} catch (Exception e) {

System.***out***.println(e);

continue;

}

if (command.type!=Type.***ERROR***) {

System.***out***.println("\nInterpreting..." + args[0]);

try {

*state* = sint.Eval(command, *state*);

} catch (Exception e) {

System.***err***.println(e);

}

}

} while (command != null);

}

}

}

//Sint.java

4) TypeChecker.java

// TypeChecker.java

// Static type checker for S

// 프로그래밍언어론 lab05 소프트웨어학부 컴퓨터과학전공 2016133 이유진

public class TypeChecker {

static TypeEnv *tenv* = new TypeEnv();

public static Type Check(Command p) {

if (p instanceof Decl) {

Decl d = (Decl) p;

if (*tenv*.contains(d.id))

*error*(d, "duplicate variable declaration");

else

return *Check*(d,*tenv*);

}

if (p instanceof Function) {

Function f = (Function) p;

if (*tenv*.contains(f.id))

*error*(f, "duplicate function definition");

else

return *Check*(f,*tenv*);

}

if (p instanceof Stmt)

return *Check*((Stmt) p, *tenv*);

throw new IllegalArgumentException("undefined command");

}

public static Type Check(Decl decl, TypeEnv te) {

if (decl.expr != null)

if (decl.type != *Check*(decl.expr, te))

*error*(decl, "type error: incorrect initialization to " + decl.id);

te.push (decl.id, decl.type);

return decl.type;

}

public static Type Check(Function f, TypeEnv te) { //lab05

te.push(f.id, new ProtoType(f.type, f.params));

for (Decl d : f.params)

te.push (d.id, d.type);

Type t = *Check*(f.stmt, te); // type check the function body (함수 본체 타입 검사)

if (t != f.type)

*error*(f, "incorrect return type");

for (Decl d : f.params)

te.pop();

te.pop(); //함수 타입 제거

if (t == f.type) { //리턴 타입과 비교

te.push(f.id, new ProtoType(f.type, f.params)); //타입 검사된 함수 타입 추가

return f.type;

}

else { //타입 오류

*error*(f, "incorrect return type");

return Type.***ERROR***;

}

}

static void check(boolean test, String msg) {

if (test) return;

System.***err***.println(msg);

}

static void error(Command c, String msg) {

c.type = Type.***ERROR***;

System.***err***.println(msg);

}

static Type checkError(boolean test, Type t, String error) {

if (test) return t;

else {

System.***err***.println(error);

return Type.***ERROR***;

}

}

static Type Check(Expr e, TypeEnv te) {

if (e instanceof Value) {

Value v = (Value)e;

return v.type;

}

if (e instanceof Identifier) {

Identifier id = (Identifier) e;

if (!te.contains(id))

*error*(id, "undeclared variable: " + id);

else id.type = te.get(id);

return id.type;

}

if (e instanceof Binary)

return *Check*((Binary) e, te);

if (e instanceof Unary)

return *Check*((Unary) e, te);

if (e instanceof Call)

return *Check*((Call) e, te);

if (e instanceof Array) { //공지 추가

Array ar = (Array) e;

if (!te.contains(ar.id))

*error*(ar, "undeclared variable: " + ar.id);

else if (*Check*(ar.expr, te) == Type.***INT***)

ar.type = te.get(ar.id);

else

*error*(ar, "non-int index: " + ar.expr);

return ar.type;

}

throw new IllegalArgumentException("undefined operator");

}

static Type Check(Unary u, TypeEnv te) {

Type t1 = *Check*(u.expr, te);

switch (u.op.val) {

case "!":

if (t1 == Type.***BOOL***)

u.type = Type.***BOOL***;

else *error*(u, "! has non-bool operand");

break;

case "-":

if (t1 == Type.***INT***)

u.type = Type.***INT***;

else *error*(u, "Unary - has non-int operand");

break;

default:

throw new IllegalArgumentException("undefined operator");

}

return u.type;

}

static Type Check(Binary b, TypeEnv te) {

Type t1 = *Check*(b.expr1, te);

Type t2 = *Check*(b.expr2, te);

switch(b.op.val) {

case "+": case "-": case "\*": case "/":

if (t1 == Type.***INT*** && t2 == Type.***INT***)

b.type = Type.***INT***;

else

*error*(b, "type error for " + b.op);

break;

case "<": case "<=": case ">": case ">=": case "==": case "!=":

if (t1 == t2)

b.type = Type.***BOOL***;

else

*error*(b, "type error for " + b.op);

break;

case "&": case "|":

if ( t1 == Type.***BOOL*** && t2 == Type.***BOOL***)

b.type = Type.***BOOL***;

else

*error*(b, "type error for " + b.op);

break;

default:

throw new IllegalArgumentException("undefined operator");

}

return b.type;

}

public static Type Check(Stmt s, TypeEnv te) {

if ( s == null )

throw new IllegalArgumentException( "AST error: null statement");

if (s instanceof Empty)

return Type.***VOID***;

if (s instanceof Assignment)

return *Check*((Assignment) s, te);

if (s instanceof Stmts)

return *Check*((Stmts) s, te);

if (s instanceof Read)

return *Check*((Read) s, te);

if (s instanceof Print)

return *Check*((Print) s, te);

if (s instanceof If)

return *Check*((If) s, te);

if (s instanceof While)

return *Check*((While) s, te);

if (s instanceof Let)

return *Check*((Let) s, te);

if (s instanceof Call)

return *Check*((Call) s, te);

if (s instanceof Return)

return *Check*((Return) s, te);

throw new IllegalArgumentException("undefined statement");

}

static Type Check(Print p, TypeEnv te) {

Type t = *Check*(p.expr,te);

if (t != Type.***ERROR***)

p.type = Type.***VOID***;

else

*error*(p, "type error in expr: " + p.expr);

return p.type;

}

static Type Check(Read r, TypeEnv te) {

Type t = *Check*(r.id, te);

if ( t == Type.***INT*** || t == Type.***BOOL*** || t==Type.***STRING***)

r.type = Type.***VOID***;

else

*error*(r, " undefined variable in read: " + r.id);

return r.type;

}

static Type Check(Return r, TypeEnv te) {

// check(te.contains(r.fid), "undefined function: " + r.fid);

Type t = *Check*(r.expr,te);

if (t == Type.***ERROR***)

*error*(r, "type error in expr: " + r.expr);

else

r.type = t;

return r.type;

}

static Type Check(Assignment a, TypeEnv te) { //공지 코드

if (a.ar != null) { // lab04 추가

if (!te.contains(a.ar.id)) {

*error*(a, "undefined variable in assignment: " + a.ar.id);

return Type.***ERROR***;

}

Type t1 = te.get(a.ar.id);

Type t2 = *Check*(a.ar.expr, te);

Type t3 = *Check*(a.expr, te);

if (t1 == t3 && t2 == Type.***INT***)

a.type = Type.***VOID***;

else

*error*(a, "mixed mode assignment to " + a.ar.id + " : " + t1 + " <- " + t2);

return a.type;

}

if (!te.contains(a.id)) {

*error*(a, "undefined variable in assignment: " + a.id);

return Type.***ERROR***;

}

Type t1 = te.get(a.id);

Type t2 = *Check*(a.expr, te);

System.***err***.println(t1 +" <- " + t2);

if (t1 == t2)

a.type = Type.***VOID***;

else

*error*(a, "mixed mode assignment to " + a.id);

return a.type;

}

static Type Check(If c, TypeEnv te) {

Type t = *Check*(c.expr,te);

Type t1 = *Check*(c.stmt1, te);

Type t2 = *Check*(c.stmt2, te);

if (t == Type.***BOOL***)

if (t1 == t2)

c.type = t1;

else

*error*(c, "non-equal type in two branches");

else

*error*(c, "non-bool test in condition");

return c.type;

}

static Type Check(While l, TypeEnv te) {

Type t = *Check*(l.expr,te);

Type t1 = *Check*(l.stmt, te);

if (t == Type.***BOOL***)

if (t1 == Type.***VOID***)

l.type = t1;

else

*error*(l, "return in loop..");

else

*error*(l, "non-bool test in loop");

// System.out.println(l.type);

return l.type;

}

static Type Check(Stmts ss, TypeEnv te) {

Type t = Type.***VOID***;

for (int i=0; i < ss.stmts.size(); i++) {

t = *Check*(ss.stmts.get(i), te);

if (t != Type.***VOID*** && i != ss.stmts.size()-1)

*error*(ss, "return in block");

}

if (ss.type != Type.***ERROR***) ss.type = t;

return ss.type;

}

static Type Check(Let l, TypeEnv te) {

// System.out.println("\nType env:");

*addType*(l.decls, te);

l.type = *Check*(l.stmts, te);

*deleteType*(l.decls, te);

return l.type;

}

static Type Check(Call c, TypeEnv te) {

if (!te.contains(c.fid)) {

*error*(c, "undefined function: " + c.fid);

return c.type;

}

Exprs args = c.args;

ProtoType p = (ProtoType)te.get(c.fid);

c.type = p.result;

// check arguments against the ProtoType

if (args.size() == p.params.size()) {

for (int i=0; i<args.size(); i++) { //인수와 매개변수 비교

Expr e = (Expr)args.get(i);

Type t1 = *Check*(e,te);

Type t2 = ((Decl)p.params.get(i)).type;

if (t1 != t2)

*error*(c, "argument type does not match parameter");

}

} else

*error*(c, "do not match numbers of arguments and params");

return c.type;

}

public static TypeEnv addType (Decls ds, TypeEnv te) {

// put the variable decls into a symbol table(TypeEnv)

if (ds != null)

for (Decl decl : ds)

*Check*(decl, te);

return te;

}

static TypeEnv deleteType(Decls ds, TypeEnv te) {

if (ds != null)

for (Decl decl : ds)

te.pop();

return te;

}

// check arguments for a Call against a ProtoType

public static void checkProtoType (ProtoType p, TypeEnv te, Exprs args) {

*check* (args.size() == p.params.size(), "match numbers of arguments and params");

for (int i=0; i<args.size(); i++) { // match arg types with param types

Expr e1 = (Expr)args.get(i);

Type t = ((Decl)p.params.get(i)).type;

*check*(*Check*(e1, te).equals(t), "argument type does not match parameter");

}

}

public static void main(String args[]) {

Command command = null;

if (args.length == 0) {

Sint sint = new Sint();

Lexer.*interactive* = true;

System.***out***.print(">> ");

Parser parser = new Parser(new Lexer());

do { // Program = Command\*

if (parser.token==*Token*.***EOF***)

parser.token = parser.lexer.getToken();

try {

command = parser.command();

// command.display(0); // display AST

if (command == null)

throw new Exception();

else {

command.type = TypeChecker.*Check*(command);

System.***out***.println("\nCommand type :" + command.type);

}

} catch (Exception e) {

System.***err***.println("Error: " + e);

System.***out***.print(">> ");

continue;

}

System.***out***.print(">> ");

} while(true);

}

else {

System.***out***.println("Begin parsing... " + args[0]);

Parser parser = new Parser(new Lexer(args[0]));

do {

if (parser.token==*Token*.***EOF***)

break;

try {

command = parser.command();

// command.display(0); // display AST

if (command == null)

throw new Exception();

else {

command.type = TypeChecker.*Check*(command);

System.***out***.println("\nCommand type :" + command.type);

}

} catch (Exception e) {

System.***err***.println("Error: " + e);

continue;

}

} while (command != null);

}

} //main

}