CS323 Project3

Intermediate-Code Generation

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I. Overview

In this project, we are required to implement the generation of intermediate code of given programs with SPL language. We suppose that there is no lexical or semantic error. **Three Address Codes(TAC)** are generated according to given rules. Our files can be run successfully with GCC version 7.4.0, GNU Flex version 2.6.4 and GNU Bison version 3.0.4 .

II. Design and Implementation

A. InterCode

We construct the class named `InterCode` to record 24 kinds of TAC information according to appendix. An InterCode object can have at most three Operand objects for storing information. The `NONE` type is defined for unnecessary instructions which can be reduced for less instructions.

```
#include <string>
using namespace std;
enum class OpType { PLACE,LABEL,VAR,IMMEDIATE,NAME,NONE };
enum class AddrType { VALUE, ADDR };
class Operand {
public:
    OpType type;
    string name;
    AddrType addr_type = AddrType::VALUE;
    Operand(OpType type);
    Operand(OpType type, string name);
    Operand(OpType type, AddrType addrType);
    string get_name();
};
enum class InterCodeType {
    NONE = 0,LABEL,FUNCTION,ASSIGN,ADD, SUB, MUL,
DIV,ADDR,PTR,COPY,GOTO,IF_S,IF_SE,IF_B,IF_BE,IF_NE,IF_EQ,
    RETURN,DEC,PARAM,ARG,CALL,READ,WRITE
};
class InterCode {
public:
    InterCodeType interCodeType;
    Operand *x{};
    Operand *y{};
    Operand *z{};
    InterCode();
    InterCode(int type, Operand *x = nullptr, Operand *y = nullptr, Operand *z =
nullptr);
    void print();
};
```

B. Translate

After that, we continue to build up translate functions for expressions, statements, arguments and so on. According to the given schemes tables, we implement the translate action for each rule. The results are stored in `vector<InterCode>` since the result may contains more than one TAC instruction. We use merge method to construct TAC result for `ExtDef` , `CompSt`, `DefList` and `StmtList` since we can translate them using their children components.

When translating, we may need to new place, label, variable or immediate number. We set `new_place()` , `new_label()` , `get_varOp()` and `new_immediate()` functions to generate them. Specially, we will not give exact id for new place, new label and new variable, which will be given when constructing result(Designed in `InterCode.cpp`).

```
15      if (name.empty()) {
16          switch (type) {
17              case OpType::PLACE:
18                  name = to_string(++cnt_place);
19                  break;
20              case OpType::LABEL:
21                  name = to_string(++cnt_label);
22                  break;
23              case OpType::VAR:
24                  name = to_string(++cnt_var);
25                  break;
26              default:
27                  break;
28          }
29      }
```

Figure.1 Using global counters to give names

C. Bonus

1. What's more, we support translating array declaration which is provided in `translate_arr()` , and `translate_arr_Dec()` functions. Also, we modify the class `spl_type` and add an int member `size` for it to store the space cost for possible usages. `translate_arr_addr()` are used for computing offset when fetching the address.

```
453     InterCode translate_arr_Dec(Node *varDec){
454         if(varDec->child.size()==1){return {};}
455         while(varDec->child.size()!=1){
456             varDec = varDec->child[0];
457         }
458         string name = varDec->get_name();
459         int size = getTypeByName(name)->size;
460         Operand *x = get_varOp(name);
461         Operand *y = new Operand(OpType::IMMEDIATE,to_string(size));
462         return InterCode( type: 19,x,y);
463     }
```

Figure.2 `translate_arr_Dec()` function

When translating array or structure, we can start from its primitive type which is set in type constructor. Using them and the array dimensions or struct contents to count for final space cost. It's useful for TAC-19 which is `DEC x [size]` .

```
Type::Type(string name, string pri): name(name), category(CATEGORY::PRIMITIVE) {
    if(pri == "int"){type.pri = Primitive::INT; size = 4;}
    else if(pri=="float"){type.pri = Primitive::FLOAT; size = 8;}
    else if(pri == "char"){type.pri = Primitive::CHAR; size = 2;}
}
```

Figure.3 Set size for primitive type

2. We support `For` statements' translation which is implemented in `vector<InterCode> translate_Stmt(Node *stmt)` . Its actions are similar as `While` 's actions.

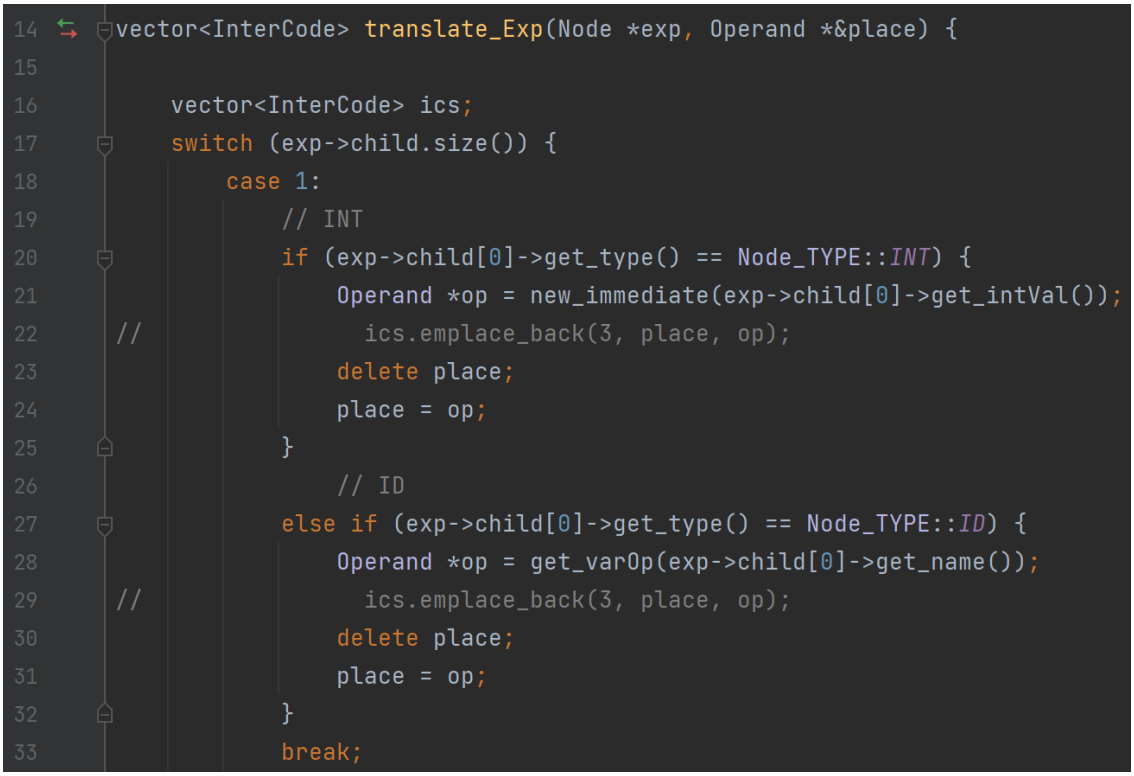
```
    // FOR LP Def Exp SEMI Exp RP Stmt
    else if (stmt->child.size() == 8) {
        // Def
        vector<InterCode> def = translate_Def(stmt->child[2]);
        translate.insert(translate.end(), def.begin(), def.end());
        // WHILE Exp_2 Stmt + Exp_3
        Operand *lb1 = new_label();
        Operand *lb2 = new_label();
        Operand *lb3 = new_label();
        vector<InterCode> exp2 = translate_cond_Exp(stmt->child[4], lb2, lb3);
        vector<InterCode> code1 = translate_Stmt(stmt->child[8]);
        Operand *tp2 = new_place();
        vector<InterCode> code2 = translate_Exp(stmt->child[6], tp2);
        translate.emplace_back(1, lb1);
        translate.insert(translate.end(), exp2.begin(), exp2.end());
        translate.emplace_back(1, lb2);
        translate.insert(translate.end(), code1.begin(), code1.end());
        translate.insert(translate.end(), code2.begin(), code2.end());
        translate.emplace_back(11, lb1);
        translate.emplace_back(1, lb3);
    }
```

Figure.4 Translation For Statements

3.

D. Optimization

1. When translating expressions, if the expression is a single INT or or ID, we don't need to store the operand in given place. Thus, we will not add the TAC instruction into translation result.



```
vector<InterCode> translate_Exp(Node *exp, Operand *&place) {

    vector<InterCode> ics;
    switch (exp->child.size()) {
        case 1:
            // INT
            if (exp->child[0]->get_type() == Node_TYPE::INT) {
                Operand *op = new_immediate(exp->child[0]->get_intVal());
//                ics.emplace_back(3, place, op);
                delete place;
                place = op;
            }
                // ID
            else if (exp->child[0]->get_type() == Node_TYPE::ID) {
                Operand *op = get_varOp(exp->child[0]->get_name());
//                ics.emplace_back(3, place, op);
                delete place;
                place = op;
            }
            break;
```

Figure.5 Delete unnecessary instructions

2.

III. Test Cases

For extra test cases, we put them in `./test-ex/` folder which contains four test cases. They are used for arrays&structures' translation, for-statements' translation, ...

- Test case with Array Translation

```
// TBD
-----------------------------------------------
// TBD
```

IV. Instructions

Change directory to the root path and using `make splc` to create `splc` in `./bin` root for spl codes' parsing. Then using `bin/splc <test_root>/<test_file_name>` to create immediate code result. And you can use `make clean` to delete all created files.