Master

Compiler 2016

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About name

Master Compiler was named after a role in Doctor Who: The Master.

Properties

It's a simple(slow) & naive(not efficient) implementation of a superset of Mx* in which member function/method is permitted.

Structure

Procedures

- Parser: From source code to AST.
- From AST to Linear IR.
- From Linear to CFG(with a subtle optimization).
- Register allocation.
- From IR to MIPS.

Front End

Parser

ANTLR: source code -> CST.

AST

Convert CST to AST:

Firstlistener: Initialize, and collect all class names.

Secondlistener: Collect all function names and arguments.

Thirdlistener: Construct the whole AST.

Front End

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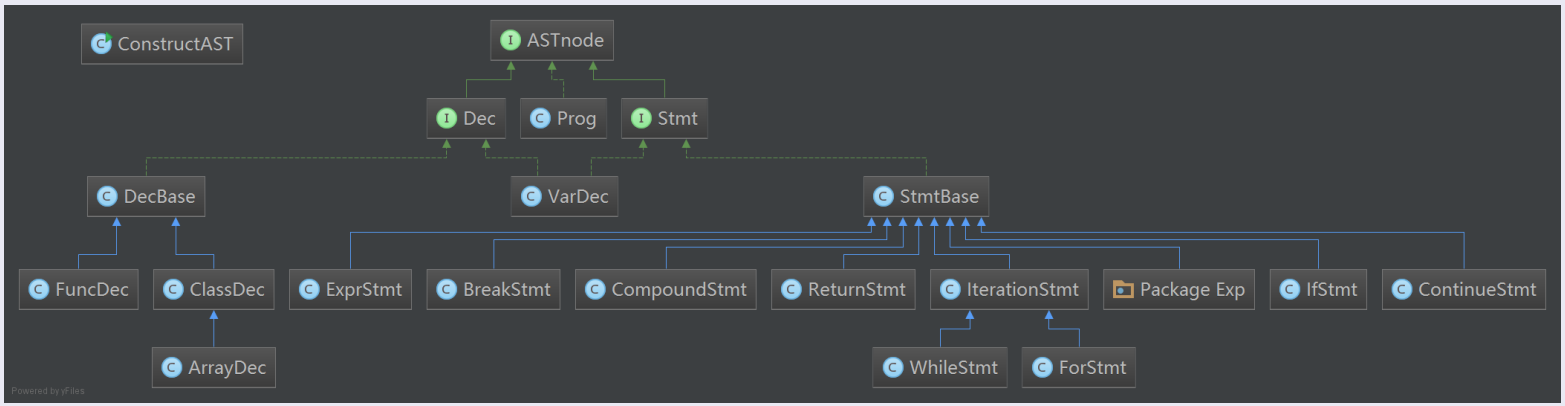
Front End

Structure of AST



Front End

Some special AST nodes:

Type: ClassDec is used to distinguish different types.(Builtin classs such as int, bool, string are defined in the Utility.h)

Symbol: VarDec is used to distinguish different symbols.

Front End

Structure of Symbol Table

Symbol table(called Scope) is nested in AST nodes.

```
public class Scope {
    Scope previous = null;
    public Map<String, Dec> dict =
            new IdentityHashMap<>();

    public Scope(Scope previous) {
        this.previous = previous;
    }

    public Dec lookUp(String name) {
        Dec ret = dict.get(name);
        if (previous == null)
            return ret;
        if (ret == null)
            return previous.lookUp(name);
        else return ret;
    }

    public Dec lookUpInThisScope(String name) {
        return dict.get(name);
    }

    public void addEntry(String name, Dec symbol) {
        dict.put(name, symbol);
    }
}
```

Back End

Linear IR & CFG

- IR design: a three-address IR with infinite virtual registers(LLIR).
- Generate linear IR: Prog.emit();
- Convert linear IR to CFG: divide linear IR into basicblocks and collect all basicblocks in the same function together.

Back End

A trivial optimizations

- Since there are some basicblocks like:

```
__ifFalse0:
j __end0
```

combining these labels become necessary. By using the same method as union-find set, we can replace each label with the nearest one that really make sense.

Liveness Analysis & Register Allocation

Interference graph :

Iteration algorithm, instruction by instruction.

Coloring :

Greedy algorithm(color the vertex with minimum degree each step).

Liveness Analysis & Register Allocation

- $v0, $v1 are used to store temporary variables of Three-address code.
- $a0, $a1, $a2 are used as first 3 function arguments.
- Most of other machine registers($ra, $at, $0, exclusively)ar used in register allocation.
- MIPS instructions like 'move $r0, $r0' will be eliminated.

Example

Member function:

```
class Report {
    string reportname;
    void init(string name) {
        this.reportname = name;
    }
    void print() {
        println(this.reportname);
    }
}
int n = 100;

class Professor {
    Report report;
    string attitude;
    void init(Report report, int attitude) {
        this.report = report;
        if (attitude == 0) {
            this.attitude = "Accept!";
        }
        if (attitude == 1) {
            this.attitude = "Excited!";
        }
        if (attitude > 1) {
            this.attitude = "Sunny!";
        }
    }
    void print() {
        println(this.attitude);
    }
}

int main() {
    Report reportOfProfessorJiang = new Report;
    reportOfProfessorJiang.init("Trends in the Development of Energy Resources and Major Approaches to Their Economization.");
    reportOfProfessorJiang.print();
    Professor[] aHundredProfessorInSJTU = new Professor[n];
    int i;
    for (i = 0; i < 100; i++) {
        aHundredProfessorInSJTU[i] = new Professor;
        aHundredProfessorInSJTU[i].init(reportOfProfessorJiang, i % 3);
    }
    for (i = 0; i < 100; i++) {
        aHundredProfessorInSJTU[i].print();
    }
    return 0;
}
```

Example

Member function:

```
Trends in the Development of Energy Resources and Major Approaches to Their Economization.
Accept!
Excited!
Sunny!
Accept!
Excited!
Sunny!
Accept!
Excited!
Sunny!
Accept!
Excited!
Sunny!
Accept!
Excited!
Sunny!
Accept!
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Sunny!
Accept!
Excited!
Sunny!
Accept!
Excited!
Sunny!
Accept!
Excited!
Sunny!
Accept!
Excited!
Sunny!
```

Thanks

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