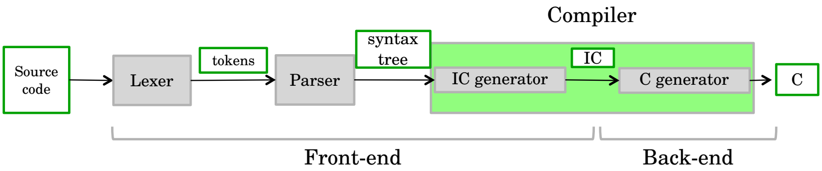
Formal Languages and Compilers - Exercises
Lecture 11
Intermediate Language, Array And Subprograms

04/05/2012

Outline

Compiler for Crème CAraMeL



Intermediate language

```
ADD   val1  val2 dest  - sum
CPY   src   NULL dest  - copy
CGE   val1  val2 dest  - copy greater or equal
GOTO  label NULL NULL  - unconditional jump
JNE   val1  val2 label - conditional jump
OUT   val   NULL NUL   - print
AGET  addr  idx  dest  - read array
ASET  addr  idx  src   - write array
PARAM val   NULL NULL  - add a parameter on the stack
CALL  id    NULL NULL  - call a procedure
CALL  id    NULL dest  - call a function
```

Implementation details

- Memory cells: union of int and float
- Two different vectors: stack and “registers”
- Allocation of variables: assignment of offset in the stack
- Allocation of temporal values: assignment of a new register

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Example

```
        CPY   INT: 1        NULL       offset 0
        CPY   INT: 5        NULL       offset 2
        CPY   INT: 1        NULL       offset 1
Label2: CGE   offset 2      offset 1   reg[1].i
        JNE   reg[1].i      INT: 1     Label nr. 1
        OUT   offset 1      NULL       NULL
        MUL   offset 0      offset 1   reg[2].i
        CPY   reg[2].i      NULL       offset 0
        ADD   offset 1      INT: 1     reg[3].i
        CPY   reg[3].i      NULL       offset 1
        NOP   NULL          NULL       NULL
        GOTO  Label nr. 2   NULL       NULL
Label1: OUT   offset 0      NULL       NULL
        NOP   NULL          NULL       NULL
        HALT  NULL          NULL       NULL
```

Outline

Intermediate.ml

- Define the instructions of intermediate code and all types of operands:
  - inst_type: `ADD`, `MUL`, `CPY`,...
  - label, offset for variables, register for temporal values
- class `intermediateCode`
- `dec_table`: declaration table binds ide with `(int, int, element)`

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Vectors and matrices: compilation

```
var m : array[5] of int;
var v : array[3,2] of int
...
for i := 0 to 2 do begin
  for j := 0 to 1 do begin
         v[i,j] := i + j
  end
end
```

Vectors and matrices in the compiler - 1

- Declaration in style of C:
  `var v : array[4,2] of int`
- Access like before:
  `v[2,1] := 45;`
- No Virtual Origin (or better, V.O.$= \alpha$)
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Vectors and matrices in the compiler - 2

Declaration: add dimensions to the declaration table

Semantic control: `v[i,j]` is OK iff `i` and `j` are integers and within the bounds

Evaluate expression: calculate the position + `AGET` instruction

Assignment: calculate the position + `ASET` instruction

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Subprograms in Crème CAraMeL: compilation

```
program
  var x : int

  function fact(a: int): int
    var b : int
  begin
    if (a = 0) then
        fact := 1
    else begin
        b := call fact(a - 1);
        fact := a * b
    end
  end

  begin
    x := call fact(12);
    write(x)
  end
```

Output

```
479001600
```

Subprograms in the compiler

- Syntax: the same as in the interpreter
- Table of subprograms
- Managing stack pointer and base pointer
- Call: push on the stack (param) + call
- Using one register for the return of the functions
- Declaration: Building and Subroutine (return type of the functions)
- Generation of the code: `subroutines.ml`
- Parameters and local variables: stack!
- Call: `commands.ml` and `expressions.ml`

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