Code Generation

Dr. Phung Nguyen

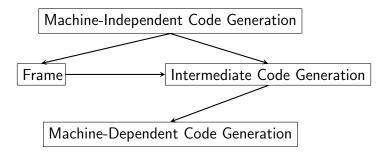
Faculty of Computer Science and Engineering University of Technology HCMC Vietnam National University

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Outline

Translation to a stack-based machine

Code Generation Design



3/15

Machine-Dependent Code Generation

- Generating specified machine code
 E.g.: emitLDC(20) → "ldc 20"
- Implemented in JasminCode

Intermediate Code Generation

- Depend on both language and machine
 Select instructions
 emitREADVAR(a)
 emitFLOAD(index)
- Select data objects
- Simulate the execution of the machine
 - \triangleleft emitICONST \rightarrow push()
 - \triangleleft emitISTORE \rightarrow pop()
- Implemented in class Emitter

Directives Generation APIs

- emitVAR(self,index, varName, inType, fromLabel, toLabel)
 .var 0 is this Lio; from Label0 to Label1
- emitATTRIBUTE(self, lexeme, inType, isFinal, value = None)
 field public static writer Ljava/io/Writer;
- emitMETHOD(self, lexeme, inType, isStatic)
 .method public foo(I)I
- emitENDMETHOD(self, frame)

 limit stack 1
 limit locals 1
 end method
- emitPROLOG(self, name, parent)

 .source io.java
 .class public io
 .super java/lang/Object

Type

- class IntType(Type)
- class FloatType(Type)
- class StringType(Type)
- class VoidType(Type)
- class BoolType(Type)
- class ClassType(Type): # cname:str
- class ArrayType(Type): # eleType:Type,dimen:List[int]
- class MType(Type): # partype:List[Type],rettype:Type

Operation Generation APIs

- emitADDOP(self, lexeme, inType, frame) \Rightarrow iadd, fadd, isub, fsub
- emitMULOP(self, lexeme, inType, frame) ⇒ imul, fmul, idiv, fdiv
- emitDIV(self, frame) ⇒ idiv
- emitMOD(self, frame) ⇒ irem
- emitANDOP(self, frame) \Rightarrow iand
- emitOROP(self, frame) ⇒ ior
- emitREOP(self, op, inType, frame) \Rightarrow code for >, < >=, <=, !=, ==
- ullet emitRELOP(self, op, inType, trueLabel, falseLabel, frame) \Rightarrow code for condition in if statement

Read/Write Variables APIs

- emitREADVAR(self, name, inType, index, frame) ⇒ [ifa]load
- emitALOAD(self, inType, frame)) ⇒ [ifa]aload
- emitWRITEVAR(self, name, inType, index, frame) \Rightarrow [ifa]store
- emitASTORE(self, inType, frame) \Rightarrow [ifa]astore
- emitGETSTATIC(self, lexeme, inType, frame) ⇒ getstatic
- ullet emitGETFIELD(self, lexeme, inType, frame) \Rightarrow getfield
- $\bullet \ \, \mathsf{emitPUTSTATIC}(\mathsf{self}, \, \mathsf{lexeme}, \, \mathsf{inType}, \, \mathsf{frame}) \Rightarrow \mathsf{putstatic}$
- $\bullet \ \ \mathsf{emitPUTFIELD}(\mathsf{self}, \ \mathsf{lexeme}, \ \mathsf{inType}, \ \mathsf{frame}) \Rightarrow \mathsf{putfield}$

Other APIs

- ullet emitPUSHICONST(self, input, frame) \Rightarrow iconst, bipush, sipush, ldc
- emitPUSHFCONST(self, input, frame) ⇒ fconst, ldc
- emitINVOKESTATIC(self, lexeme, inType, frame) ⇒ invokestatic
- emitINVOKESPECIAL(self, frame, lexeme=None, inType=None)
 invokespecial
- emitINVOKEVIRTUAL(self, lexeme, inType, frame) ⇒ invokevirtual
- emitIFTRUE(self, label, frame) ⇒ ifgt
- ullet emitIFFALSE(self, label, frame) \Rightarrow ifle
- emitDUP(self,frame) ⇒ dup
- emitPOP(self,frame) ⇒ pop
- emitl2F(self, frame) ⇒ i2f
- emitRETURN(self, inType, frame) ⇒ return, ireturn
- emitLABEL(self, label, frame) \Rightarrow Label
- emitGOTO(self, label, frame) ⇒ goto

Frame

Tools are used to manage information used to generate code for a method

- Labels: are valid in the body of a method
 - ⊲ getNewLabel(): return a new label
 - ⊲ getStartLabel(): return the beginning label of a scope
 - ⊲ getEndLabel(): return the end label of a scope
 - ⊲ getContinueLabel(): return the label where a continue should come
 - ⊲ getBreakLabel(): return the label where a break should come
 - ⊲ enterScope()
 - ⊲ exitScope()
 - ⊲ enterLoop()
 - ⊲ exitLoop()

Frame (cont'd)

- Local variable array
 - ⊲ getNewIndex(): return a new index for a variable
 - ⊲ getMaxIndex(): return the size of the local variable array
- Operand stack
 - push(): simulating a push execution
 - op(): simulating a pop execution
 - ⊲ getMaxOpStackSize(): return the max size of the operand stack
- Implemented in class Frame

Machine-Independent Code Generation

- Based on the source language
- Use facilities of Frame and Intermediate Code Generation (Emitter)

BKIT-Java mapping

- A source program \Rightarrow Java class
- A global variable ⇒ a static field
- A function \Rightarrow a static method
- ullet A parameter \Rightarrow a parameter
- A local variable \Rightarrow a local variable
- An expression \Rightarrow an expression
- A statement \Rightarrow a statement
- An invocation \Rightarrow an invocation

Summary

- Use BCEL to know which code should be generated
- Generate code for expressions first
- Generate code for statements later
- Good luck