Code Generation

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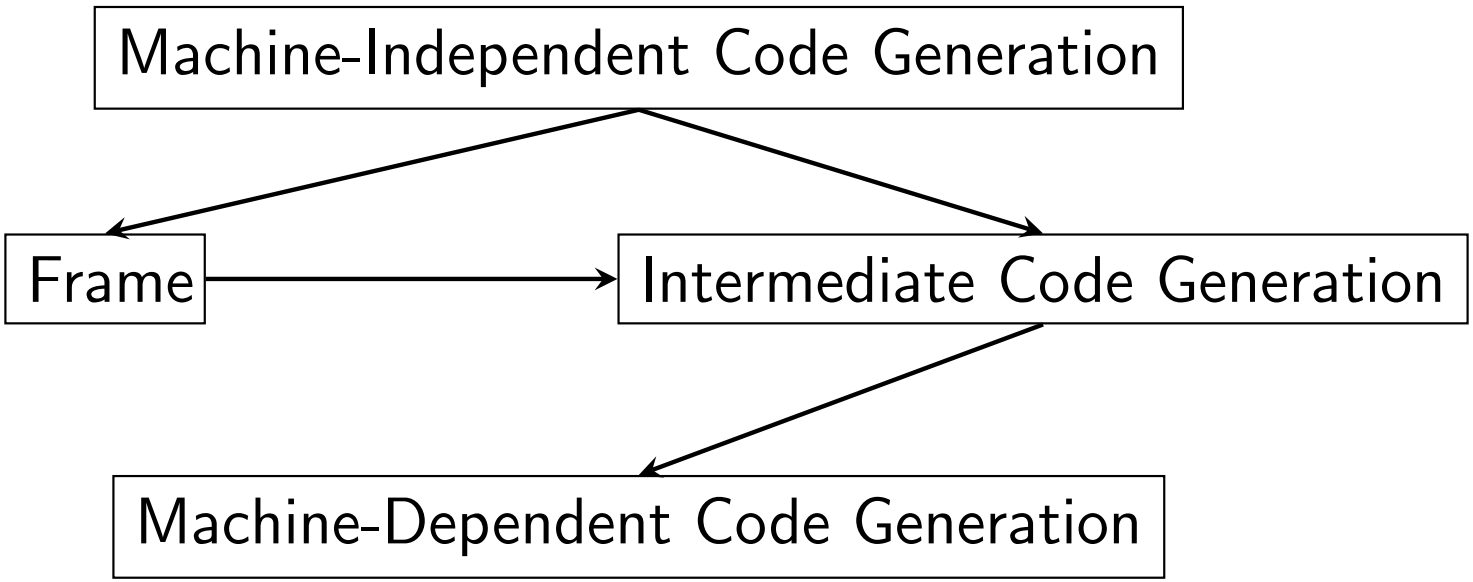
Outline

Code Generation Design

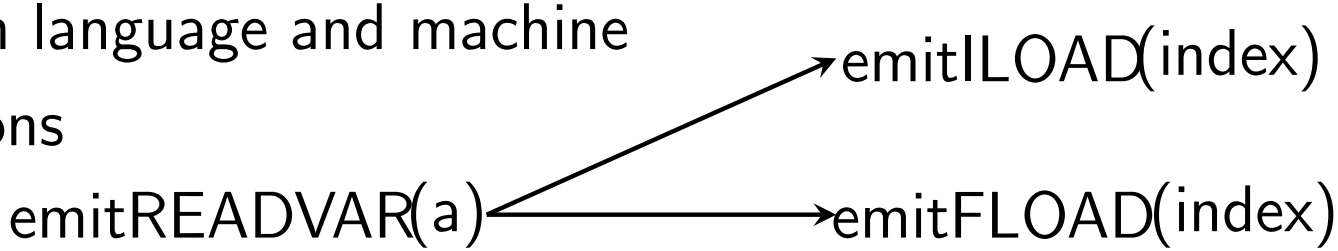


Machine-Dependent Code Generation

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

Intermediate Code Generation

- Depend on both language and machine
- Select instructions



- Select data objects
- Simulate the execution of the machine
  - ◁ emitICONST $\rightarrow$ push()
  - ◁ 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
- emitEPILOG(self)

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) $\Rightarrow$ imul, fmul, idiv, fdiv
- emitDIV(self, frame) $\Rightarrow$ idiv
- emitMOD(self, frame) $\Rightarrow$ irem
- emitANDOP(self, frame) $\Rightarrow$ iand
- emitOROP(self, frame) $\Rightarrow$ ior
- emitREOP(self, op, inType, frame) $\Rightarrow$ code for $>$, $<$ $>=$, $<=$, $!=$, $==$
- emitRELOP(self, op, inType, trueLabel, falseLabel, frame) $\Rightarrow$ code for condition in if statement

Read/Write Variables APIs

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

Other APIs

- emitPUSHICONST(self, input, frame) ⇒ 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
- emitIFFALSE(self, label, frame) ⇒ ifle
- emitDUP(self,frame) ⇒ dup
- emitPOP(self,frame) ⇒ pop
- emitI2F(self, frame) ⇒ i2f
- emitRETURN(self, inType, frame) ⇒ return, ireturn
- emitLABEL(self, label, frame) ⇒ 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
  - ◁ pop(): 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 $\Rightarrow$ a static field
- A function $\Rightarrow$ a static method
- 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