Code Generation

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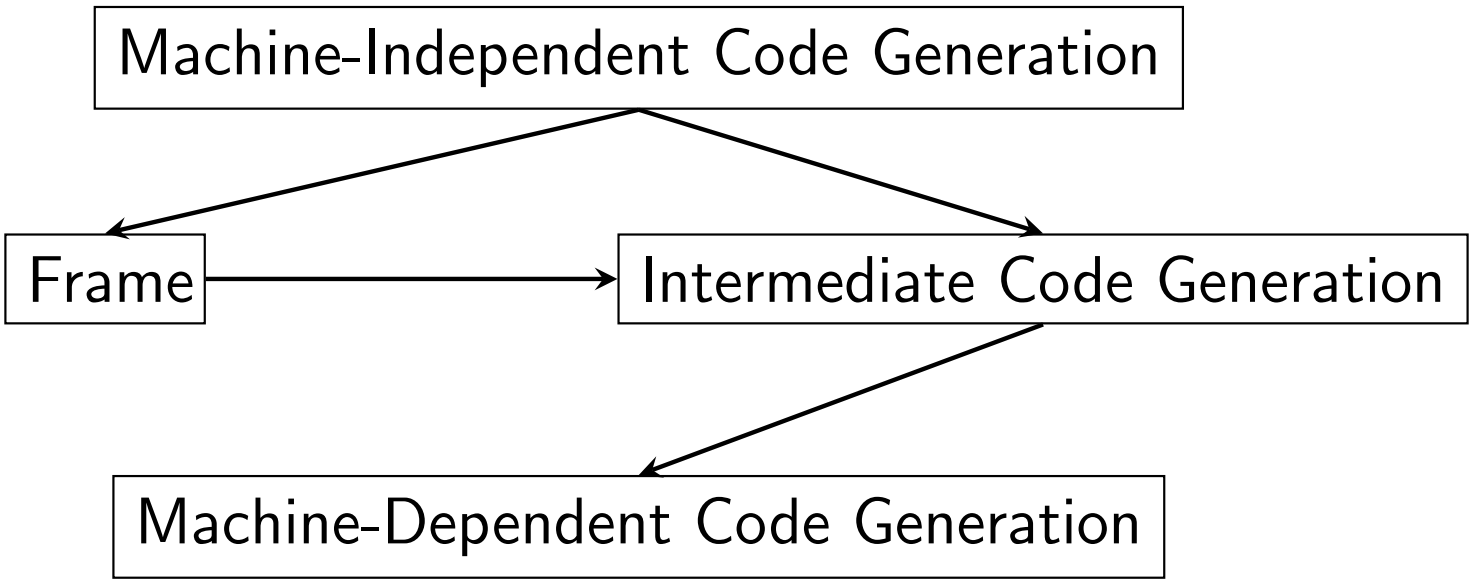
Outline

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

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- Select instructions

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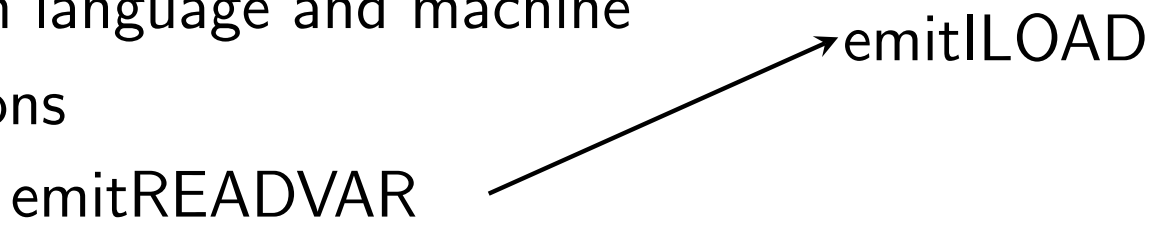

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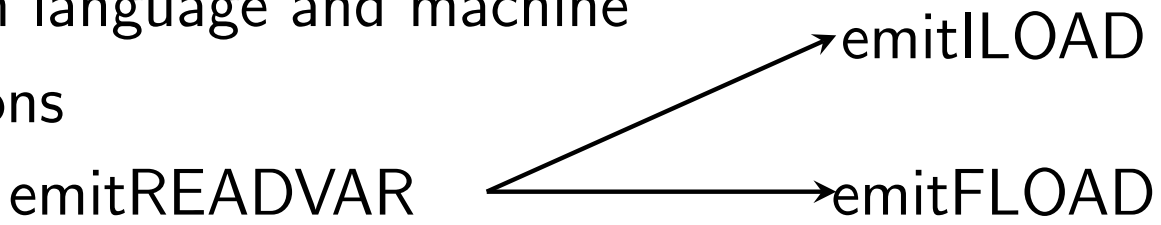

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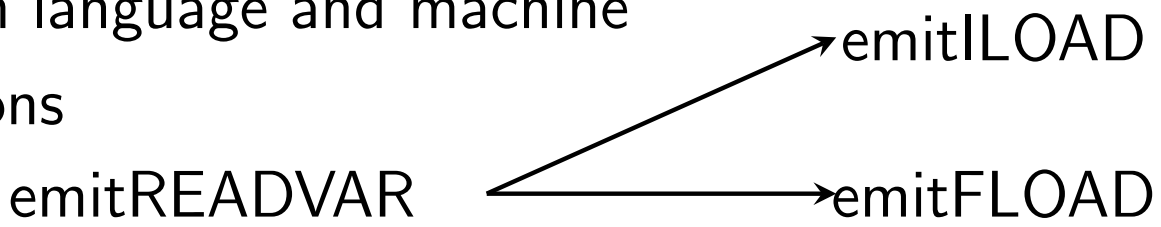

- Select data objects

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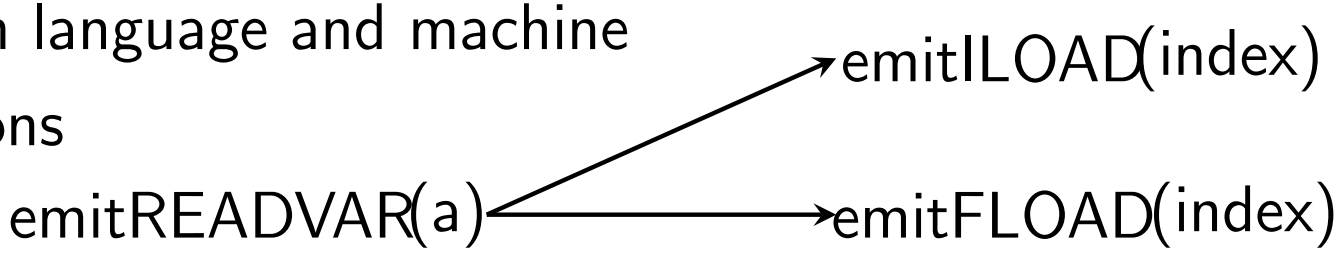

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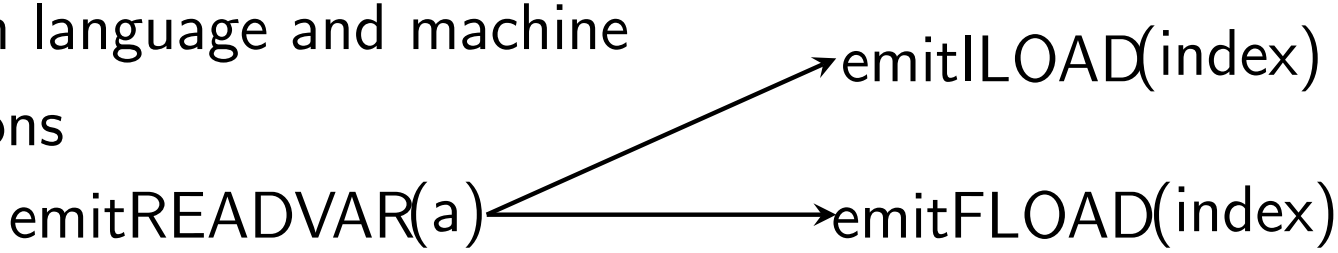

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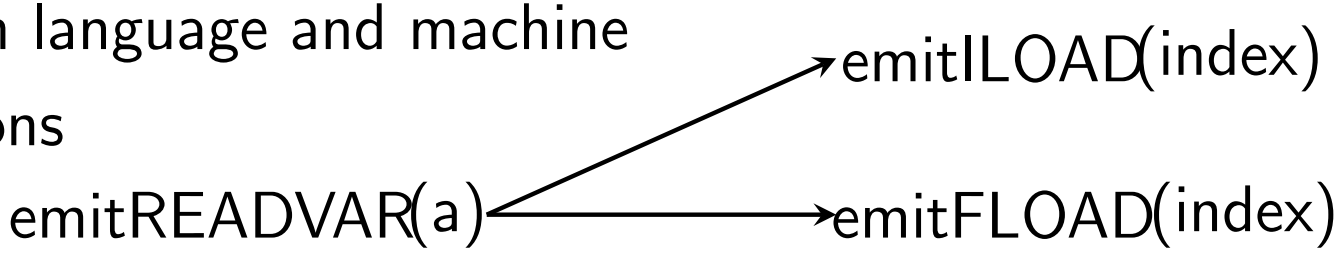

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- Simulate the execution of the machine

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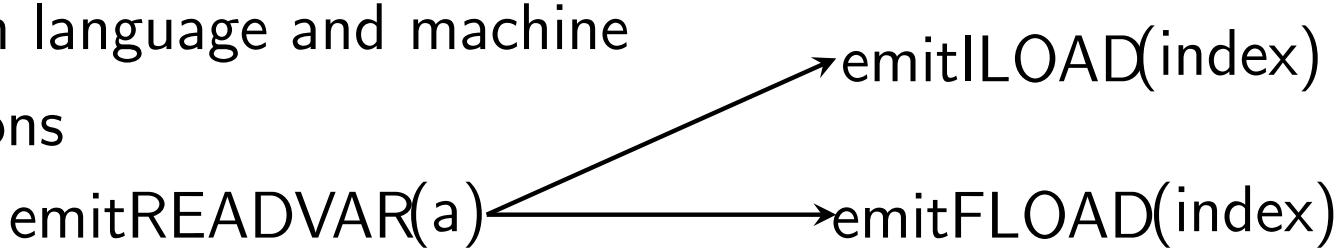

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  - ◁ emitICONST $\rightarrow$ push()

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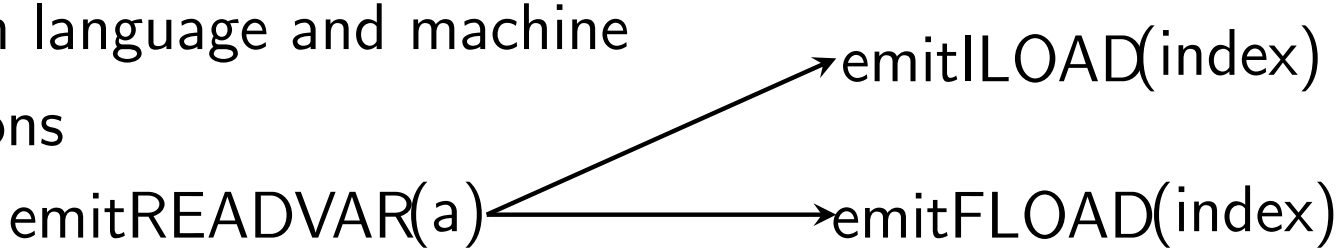

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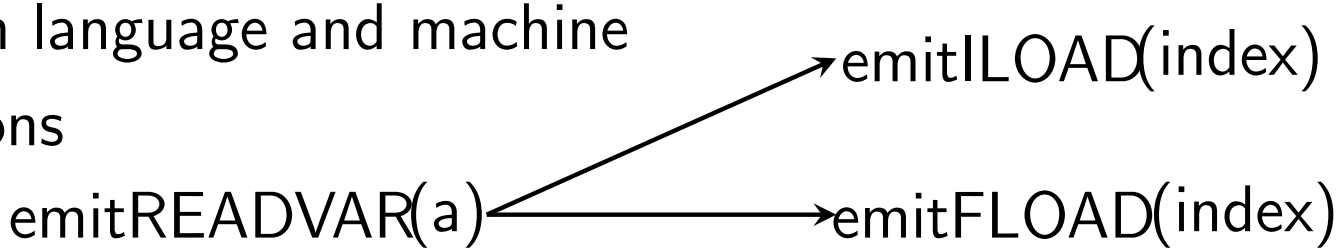

- Select data objects
- Simulate the execution of the machine
  - ◁ emitICONST $\rightarrow$ push()
  - ◁ emitISTORE $\rightarrow$ pop()
- Implemented in class Emitter

Directives Generation APIs

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  .var 0 is this Lio; from Label0 to Label1

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  .field public static writer Ljava/io/Writer;

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- emitMETHOD(self, lexeme, inType, isStatic)
  .method public foo(I)I

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  .method public foo(I)I
- emitENDMETHOD(self, frame)
  .limit stack 1
  .limit locals 1
  .end method

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  .limit stack 1
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  .end method
- emitPROLOG(self, name, parent)
  .source io.java
  .class public io
  .super java/lang/Object

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- 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

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- emitADDOP(self, lexeme, inType, frame) $\Rightarrow$ iadd, fadd, isub, fsub
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- emitDIV(self, frame) $\Rightarrow$ idiv

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- emitDIV(self, frame) $\Rightarrow$ idiv
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- emitANDOP(self, frame) $\Rightarrow$ iand

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- emitANDOP(self, frame) $\Rightarrow$ iand
- emitOROP(self, frame) $\Rightarrow$ ior
- emitREOP(self, op, inType, frame) $\Rightarrow$ code for $>$, $<$ $>=$, $<=$, $!=$, $==$

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

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- emitASTORE(self, inType, frame) $\Rightarrow$ [ifa]astore

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- emitGETSTATIC(self, lexeme, inType, frame) $\Rightarrow$ getstatic

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- emitGETFIELD(self, lexeme, inType, frame) $\Rightarrow$ getfield

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- emitGETFIELD(self, lexeme, inType, frame) $\Rightarrow$ getfield
- emitPUTSTATIC(self, lexeme, inType, frame) $\Rightarrow$ putstatic

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- emitGETSTATIC(self, lexeme, inType, frame) $\Rightarrow$ getstatic
- emitGETFIELD(self, lexeme, inType, frame) $\Rightarrow$ getfield
- emitPUTSTATIC(self, lexeme, inType, frame) $\Rightarrow$ putstatic
- emitPUTFIELD(self, lexeme, inType, frame) $\Rightarrow$ putfield

Other APIs

- emitPUSHICONST(self, input, frame) $\Rightarrow$ iconst, bipush, sipush, ldc

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- emitINVOKESTATIC(self, lexeme, inType, frame) $\Rightarrow$ invokestatic

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- emitINVOKESPECIAL(self, frame, lexeme=None, inType=None) $\Rightarrow$ invokespecial

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- emitIFTRUE(self, label, frame) $\Rightarrow$ ifgt

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- emitIFFALSE(self, label, frame) $\Rightarrow$ ifle
- emitDUP(self,frame) $\Rightarrow$ dup

Other APIs

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- emitDUP(self,frame) ⇒ dup
- emitPOP(self,frame) ⇒ pop

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- emitIFTRUE(self, label, frame) ⇒ ifgt
- emitIFFALSE(self, label, frame) ⇒ ifle
- emitDUP(self,frame) ⇒ dup
- emitPOP(self,frame) ⇒ pop
- emitI2F(self, frame) ⇒ i2f

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- emitDUP(self,frame) ⇒ dup
- emitPOP(self,frame) ⇒ pop
- emitI2F(self, frame) ⇒ i2f
- emitRETURN(self, inType, frame) ⇒ return, ireturn

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- 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

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- 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

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Frame (cont'd)

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  - ◁ getNewIndex(): return a new index for a variable
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- Operand stack

Frame (cont'd)

- Local variable array
  - ◁ getNewIndex(): return a new index for a variable
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- Operand stack
  - ◁ push(): simulating a push execution

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

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

Frame (cont'd)

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- 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

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- Generate code for statements later
- Good luck