

Code Generation

Dr. Phung Nguyen

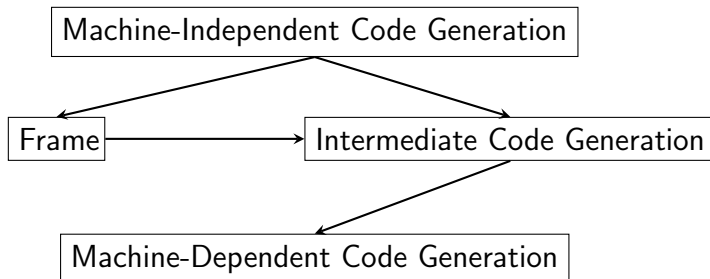
Faculty of Computer Science and Engineering
University of Technology
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Outline

1 Translation to a stack-based machine

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

Intermediate Code Generation

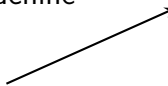
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Intermediate Code Generation

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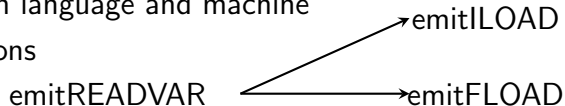
emitREADVAR

emitILOAD



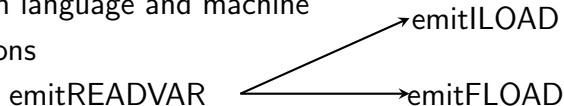
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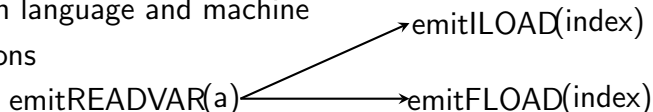
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- Select data objects

Intermediate Code Generation

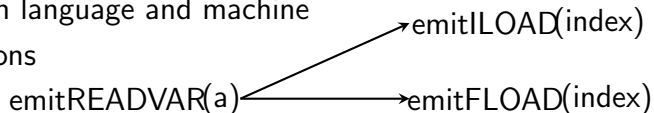
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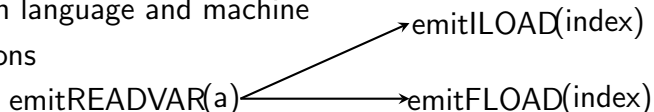
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Intermediate Code Generation

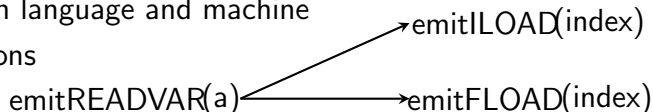
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- Select data objects
- Simulate the execution of the machine

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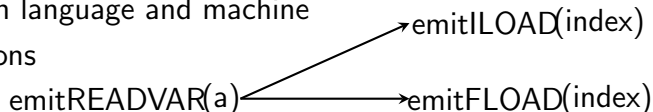
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 - ◁ `emitICONST` → `push()`

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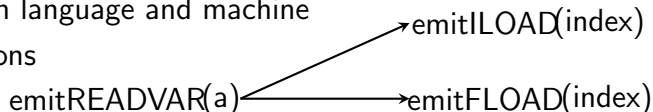
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 - ◁ `emitICONST` → `push()`
 - ◁ `emitISTORE` → `pop()`

Intermediate Code Generation

- Depend on both language and machine
- Select instructions



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

Directives Generation APIs

- emitVAR(self,index, varName, inType, fromLabel, toLabel)
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.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`

Operation Generation APIs

- `emitADDOP(self, lexeme, inType, frame) \Rightarrow iadd, fadd, isub, fsub`
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- `emitANDOP(self, frame) \Rightarrow iand`

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- `emitANDOP(self, frame) \Rightarrow iand`
- `emitOROP(self, frame) \Rightarrow ior`

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

Operation Generation APIs

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- `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

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

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- `emitPUTSTATIC(self, lexeme, inType, frame) ⇒ putstatic`

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- `emitPUTSTATIC(self, lexeme, inType, frame)` \Rightarrow `putstatic`
- `emitPUTFIELD(self, lexeme, inType, frame)` \Rightarrow `putfield`

Other APIs

- `emitPUSHCONST(self, input, frame) \Rightarrow iconst, bipush, sipush, ldc`

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- `emitINVOKEVIRTUAL(self, lexeme, inType, frame)` \Rightarrow `invokevirtual`

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- `emitPOP(self, frame) ⇒ pop`

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- `emitPOP(self, frame)` \Rightarrow `pop`
- `emitI2F(self, frame)` \Rightarrow `i2f`

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- `emitPOP(self, frame)` \Rightarrow `pop`
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- `emitRETURN(self, inType, frame)` \Rightarrow `return`, `ireturn`

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- `emitLABEL(self, label, frame)` \Rightarrow `Label`

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- emitRETURN(self, inType, frame) \Rightarrow return, ireturn
- emitLABEL(self, label, frame) \Rightarrow Label
- emitGOTO(self, label, frame) \Rightarrow goto

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Frame (cont'd)

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 - ◁ `getNewIndex()`: return a new index for a variable
 - ◁ `getMaxIndex()`: return the size of the local variable array
- Operand stack
 - ◁ `push()`: simulating a push execution

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 - ◁ `getNewIndex()`: return a new index for a variable
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 - ◁ `push()`: simulating a push execution
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 - ◁ `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)

- 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

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- Good luck