

# Languages-beta: MiniJava-Dynamics \*

The PPlanCompS Project

MiniJava-Dynamics.cbs | PLAIN | PRETTY

OUTLINE

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Language "MiniJava"

## 1 Programs

*Syntax*  $P : \text{program} ::= \text{main-class class-declaration}^*$

$MC : \text{main-class} ::= \text{'class' identifier '{'$   
     $\text{'public' 'static' 'void' 'main' '(' 'String' '[' ']' identifier ')'} \text{'{'}$   
     $\text{statement}$   
     $\text{'}'$   
     $\text{'}'$

*Semantics*  $\text{run}[[ P : \text{program} ]] : \Rightarrow \text{null-type}$

*Rule*  $\text{run}[[ \text{'class' } ID_1 \text{'{'}$   
     $\text{'public' 'static' 'void' 'main' '(' 'String' '[' ']' } ID_2 \text{' )'} \text{'{'}$   
     $S$   
     $\text{'}'$   
     $\text{'}'$   
     $CD^* ]] =$   
     $\text{scope}(\text{recursive}(\text{bound-names}[[ CD^* ]], \text{declare-classes}[[ CD^* ]]),$   
     $\text{execute}[[ S ]])$

$ID_1$  and  $ID_2$  are not referenced in  $S$  or  $CD^*$

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\*Suggestions for improvement: [plancomps@gmail.com](mailto:plancomps@gmail.com).  
Reports of issues: <https://github.com/plancomps/CBS-beta/issues>.

## 2 Declarations

### Classes

*Syntax*  $CD : \text{class-declaration} ::= \text{'class' identifier ('extends' identifier)? '{'}$   
 $\text{var-declaration}^*$   
 $\text{method-declaration}^*$   
 $\text{'}'}$

*Semantics*  $\text{bound-names} [ CD^* : \text{class-declaration}^* ] : \Rightarrow \text{sets(ids)}$

*Rule*  $\text{bound-names} [ \text{'class' } ID_1 \text{'{' } VD^* MD^* \text{'}' } ] = \{\text{id} [ ID_1 ]\}$

*Rule*  $\text{bound-names} [ \text{'class' } ID_1 \text{'extends' } ID_2 \text{'{' } VD^* MD^* \text{'}' } ] = \{\text{id} [ ID_1 ]\}$

*Rule*  $\text{bound-names} [ ] = \{ \}$

*Rule*  $\text{bound-names} [ CD CD^+ ] =$   
 $\text{set-unite}(\text{bound-names} [ CD ], \text{bound-names} [ CD^+ ])$

*Semantics*  $\text{declare-classes} [ CD^* : \text{class-declaration}^* ] : \Rightarrow \text{envs}$

*Rule*  $\text{declare-classes} [ \text{'class' } ID_1 \text{'{' } VD^* MD^* \text{'}' } ] =$

$\{\text{id} [ ID_1 ] \mapsto$   
 $\text{class}(\$   
 $\text{thunk closure}$   
 $\text{reference object}(\$   
 $\text{fresh-atom},$   
 $\text{id} [ ID_1 ],$   
 $\text{declare-variables} [ VD^* ],$   
 $\text{declare-methods} [ MD^* ])\}$

*Rule*  $\text{declare-classes} [ \text{'class' } ID_1 \text{'extends' } ID_2 \text{'{' } VD^* MD^* \text{'}' } ] =$

$\{\text{id} [ ID_1 ] \mapsto$   
 $\text{class}(\$   
 $\text{thunk closure}$   
 $\text{reference object}(\$   
 $\text{fresh-atom},$   
 $\text{id} [ ID_1 ],$   
 $\text{declare-variables} [ VD^* ],$   
 $\text{dereference force class-instantiator bound id} [ ID_2 ],$   
 $\text{declare-methods} [ MD^* ],$   
 $\text{id} [ ID_2 ])\}$

*Rule*  $\text{declare-classes} [ ] = \text{map} ( )$

*Rule*  $\text{declare-classes} [ CD CD^+ ] =$   
 $\text{collateral}(\text{declare-classes} [ CD ], \text{declare-classes} [ CD^+ ])$

### Variables

*Syntax*  $VD : \text{var-declaration} ::= \text{type identifier ';'}$

*Semantics* `declare-variables` [  $VD^* : \text{var-declaration}^*$  ] :  $\Rightarrow$  `envs`  
*Rule* `declare-variables` [  $T ID ;$  ] =  
 $\{id$  [  $ID$  ]  $\mapsto$   
`allocate-initialised-variable`(`type` [  $T$  ], `initial-value` [  $T$  ])  
*Rule* `declare-variables` [ ] = `map`( )  
*Rule* `declare-variables` [  $VD VD^+$  ] =  
`collateral`(`declare-variables` [  $VD$  ], `declare-variables` [  $VD^+$  ])

## Types

*Syntax*  $T : \text{type} ::=$  `'int'` [ `' '` ]  
| `'boolean'`  
| `'int'`  
| `identifier`

*Semantics* `type` [  $T : \text{type}$  ] :  $\Rightarrow$  `types`  
*Rule* `type` [ `'int'` [ `' '` ] ] = `vectors`(`variables`)  
*Rule* `type` [ `'boolean'` ] = `booleans`  
*Rule* `type` [ `'int'` ] = `integers`  
*Rule* `type` [  $ID$  ] = `pointers`(`objects`)

*Semantics* `initial-value` [  $T : \text{type}$  ] :  $\Rightarrow$  `minijava-values`  
*Rule* `initial-value` [ `'int'` [ `' '` ] ] = `vector`( )  
*Rule* `initial-value` [ `'boolean'` ] = `false`  
*Rule* `initial-value` [ `'int'` ] = 0  
*Rule* `initial-value` [  $ID$  ] = `pointer-null`

## Methods

*Syntax*  $MD : \text{method-declaration} ::=$  `'public'` `type` `identifier` `'('` `formal-list?` `' )'` `'{'`  
`var-declaration*`  
`statement*`  
`'return'` `expression` `' ;'`  
`'}'`

*Type* `methods`  
 $\rightsquigarrow$  `functions`(`tuples`(`references`(`objects`), `minijava-values*`), `minijava-values`)

*Semantics* `declare-methods`[[  $MD^* : \text{method-declaration}^*$  ]] :  $\Rightarrow$  `envs`

*Rule* `declare-methods`[[ 'public'  $T$   $ID$  '('  $FL^?$  ')' '{'  $VD^* S^*$  'return'  $E$  ';' '}' ]] =

```

{id[[  $ID$  ]]  $\mapsto$ 
  function closure scope(
    collateral(
      match(
        given,
        tuple(
          pattern abstraction
            { "this"  $\mapsto$ 
              allocate-initialised-variable(pointers(objects), given)},
          bind-formals[[  $FL^?$  ]]),
          object-single-inheritance-feature-map
            checked dereference first tuple-elements given,
          declare-variables[[  $VD^*$  ]]),
          sequential(execute[[  $S^*$  ]], evaluate[[  $E$  ]]))}

```

*Rule* `declare-methods`[[ ]] = `map`( )

*Rule* `declare-methods`[[  $MD MD^+$  ]] =

```

collateral(declare-methods[[  $MD$  ]], declare-methods[[  $MD^+$  ]])

```

## Formals

*Syntax*  $FL : \text{formal-list} ::= \text{type identifier} (' , ' \text{formal-list})^?$

*Semantics* `bind-formals`[[  $FL^? : \text{formal-list}^?$  ]] :  $\Rightarrow$  `patterns`\*

*Rule* `bind-formals`[[  $T$   $ID$  ]] =

```

pattern abstraction
  {id[[  $ID$  ]]  $\mapsto$ 
    allocate-initialised-variable(type[[  $T$  ]], given)}

```

*Rule* `bind-formals`[[  $T$   $ID$  ' , '  $FL$  ]] = `bind-formals`[[  $T$   $ID$  ]], `bind-formals`[[  $FL$  ]]

*Rule* `bind-formals`[[ ]] = ( )

## 3 Statements

*Syntax*  $S : \text{statement} ::= \text{'{' statement* '}'}$

```

| 'if' '(' expression ')' statement 'else' statement
| 'while' '(' expression ')' statement
| 'System' '.' 'out' '.' 'println' '(' expression ')' ';'
| identifier '=' expression ';'
| identifier '[' expression ']' '=' expression ';'

```

*Semantics*  $\text{execute}[ S^* : \text{statement}^* ] : \Rightarrow \text{null-type}$

*Rule*  $\text{execute}[ \{ S^* \} ] = \text{execute}[ S^* ]$

*Rule*  $\text{execute}[ \text{if } ( E ) S_1 \text{ else } S_2 ] =$   
 $\text{if-true-else}(\text{evaluate}[ E ], \text{execute}[ S_1 ], \text{execute}[ S_2 ])$

*Rule*  $\text{execute}[ \text{while } ( E ) S ] =$   
 $\text{while-true}(\text{evaluate}[ E ], \text{execute}[ S ])$

*Rule*  $\text{execute}[ \text{System} \text{ . } \text{out} \text{ . } \text{println } ( E ) \text{ ; } ] =$   
 $\text{print}(\text{to-string } \text{evaluate}[ E ], "\n")$

*Rule*  $\text{execute}[ ID = E ; ] =$   
 $\text{assign}(\text{bound id}[ ID ], \text{evaluate}[ E ])$

*Rule*  $\text{execute}[ ID [ E_1 ] = E_2 ; ] =$   
 $\text{assign}(\text{checked index}(\text{integer-add}(\text{evaluate}[ E_1 ], 1), \text{vector-elements assigned bound id}[ ID ]), \text{evaluate}[ E_2 ])$

*Rule*  $\text{execute}[ ] = \text{null}$

*Rule*  $\text{execute}[ S S^+ ] = \text{sequential}(\text{execute}[ S ], \text{execute}[ S^+ ])$

## 4 Expressions

*Syntax*  $E : \text{expression} ::=$  expression && expression  
 | expression < expression  
 | expression + expression  
 | expression - expression  
 | expression \* expression  
 | expression [ expression ]  
 | expression . length  
 | expression . identifier ( expression-list? )  
 | integer-literal  
 | true  
 | false  
 | identifier  
 | this  
 | new int [ expression ]  
 | new identifier ( )  
 | ! expression  
 | ( expression )

*Type* minijava-values  
 $\rightsquigarrow$  booleans | integers | vectors(variables) | pointers(objects)

*Semantics*  $\text{evaluate}[ E : \text{expression} ] : \Rightarrow \text{minijava-values}$

$\text{evaluate}[ \_ ]$  is a well-typed funcon term only when  $\_$  is a well-typed MiniJava expression.

*Rule* `evaluate[ E1 '&&' E2 ] =`  
`if-true-else(evaluate[ E1 ], evaluate[ E2 ], false)`

*Rule* `evaluate[ E1 '<' E2 ] =`  
`integer-is-less(evaluate[ E1 ], evaluate[ E2 ])`

*Rule* `evaluate[ E1 '+' E2 ] =`  
`integer-add(evaluate[ E1 ], evaluate[ E2 ])`

*Rule* `evaluate[ E1 '-' E2 ] =`  
`integer-subtract(evaluate[ E1 ], evaluate[ E2 ])`

*Rule* `evaluate[ E1 '*' E2 ] =`  
`integer-multiply(evaluate[ E1 ], evaluate[ E2 ])`

*Rule* `evaluate[ E1 '[' E2 ']' ] =`  
`assigned checked index(`  
`integer-add(evaluate[ E2 ], 1),`  
`vector-elements evaluate[ E1 ])`

*Rule* `evaluate[ E '.' 'length' ] =`  
`length vector-elements evaluate[ E ]`

*Rule* `evaluate[ E '.' ID '( EL? )' ] =`  
`give(`  
`evaluate[ E ],`  
`apply(`  
`lookup(`  
`class-name-single-inheritance-feature-map`  
`object-class-name checked dereference given,`  
`id[ ID ],`  
`tuple(given, evaluate-actuals[ EL? ])))`

*Rule* `evaluate[ IL ] = integer-value[ IL ]`

*Rule* `evaluate[ 'true' ] = true`

*Rule* `evaluate[ 'false' ] = false`

*Rule* `evaluate[ ID ] = assigned bound id[ ID ]`

*Rule* `evaluate[ 'this' ] = assigned bound "this"`

*Rule* `evaluate[ 'new' 'int' '[' E ']' ] =`  
`vector(`  
`interleave-repeat(`  
`allocate-initialised-variable(integers, 0), 1, evaluate[ E ]))`

*Rule* `evaluate[ 'new' ID '( ' )' ] =`  
`force class-instantiator bound id[ ID ]`

*Rule* `evaluate[ '! E ] = not evaluate[ E ]`

*Rule* `evaluate[ '( E )' ] = evaluate[ E ]`

*Syntax* `EL : expression-list ::= expression ( ',' expression-list)?`

*Semantics* `evaluate-actuals[ EL? : expression-list? ] : (⇒ minijava-values)*`

*Rule* `evaluate-actuals[ E ] = evaluate[ E ]`

*Rule* `evaluate-actuals[ E ', ' EL ] = evaluate[ E ], evaluate-actuals[ EL ]`

*Rule* `evaluate-actuals[ ] = ( )`

## 5 Lexemes

*Lexis*  $ID : \text{identifier} ::= \text{letter} (\text{letter} \mid \text{digit} \mid \text{'\_'})^*$

*Semantics*  $\text{id}[[ ID : \text{identifier} ]]: \Rightarrow \text{ids}$   
 $= \text{"ID"}$

*Lexis*  $IL : \text{integer-literal} ::= \text{digit}^+$   
 $\text{letter} ::= \text{'a'-'z'} \mid \text{'A'-'Z'}$   
 $\text{digit} ::= \text{'0'-'9'}$

*Semantics*  $\text{integer-value}[[ IL : \text{integer-literal} ]]: \Rightarrow \text{integers}$   
 $= \text{decimal-natural "IL"}$