Abstract Syntax Trees

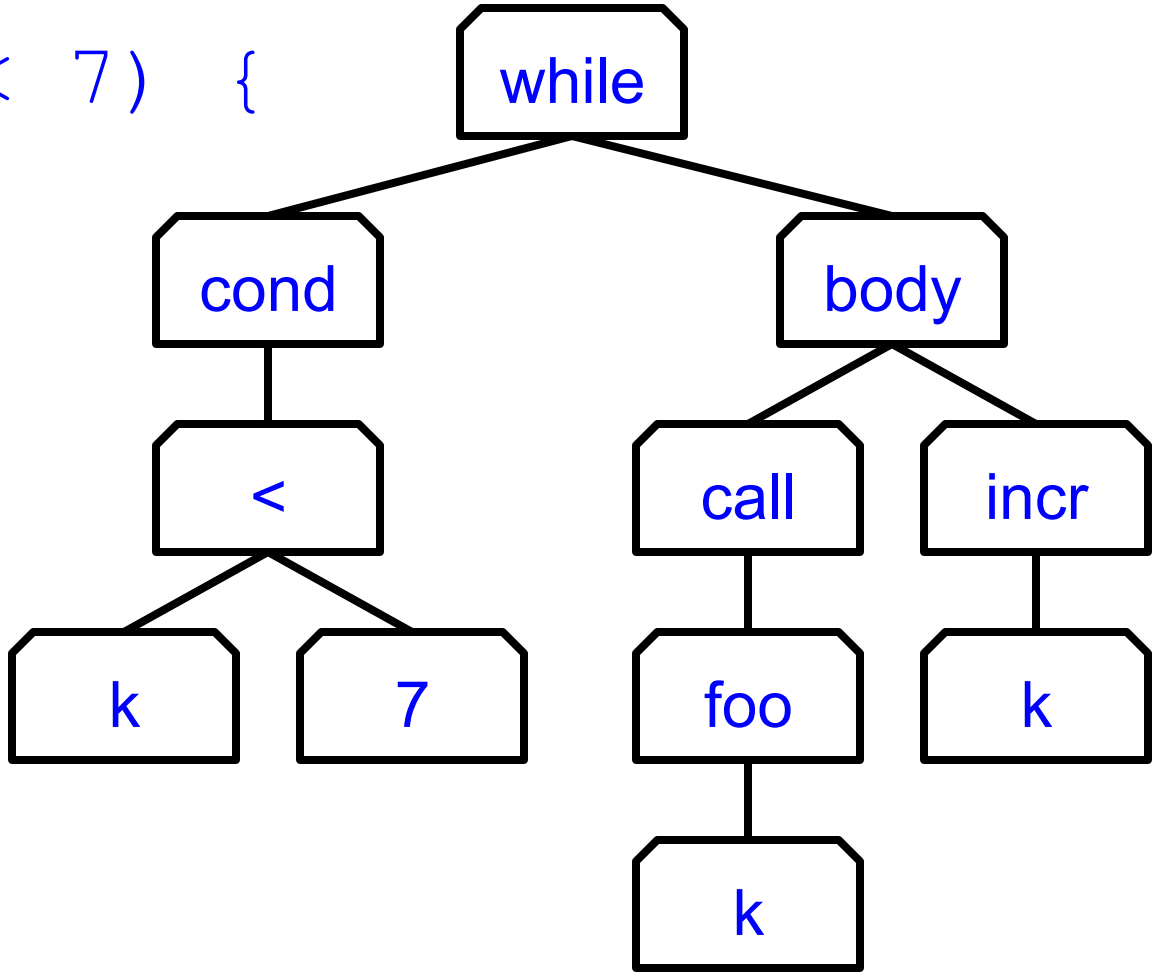



Abstract Syntax Tree

- An ***abstract syntax tree (AST)*** is a `tree` model of an entire program or a certain "program structure" (e.g., a statement or an expression in a Java program)
- An AST is "abstract" in the sense that some of the actual characters used in the "concrete" program text do not appear in the AST

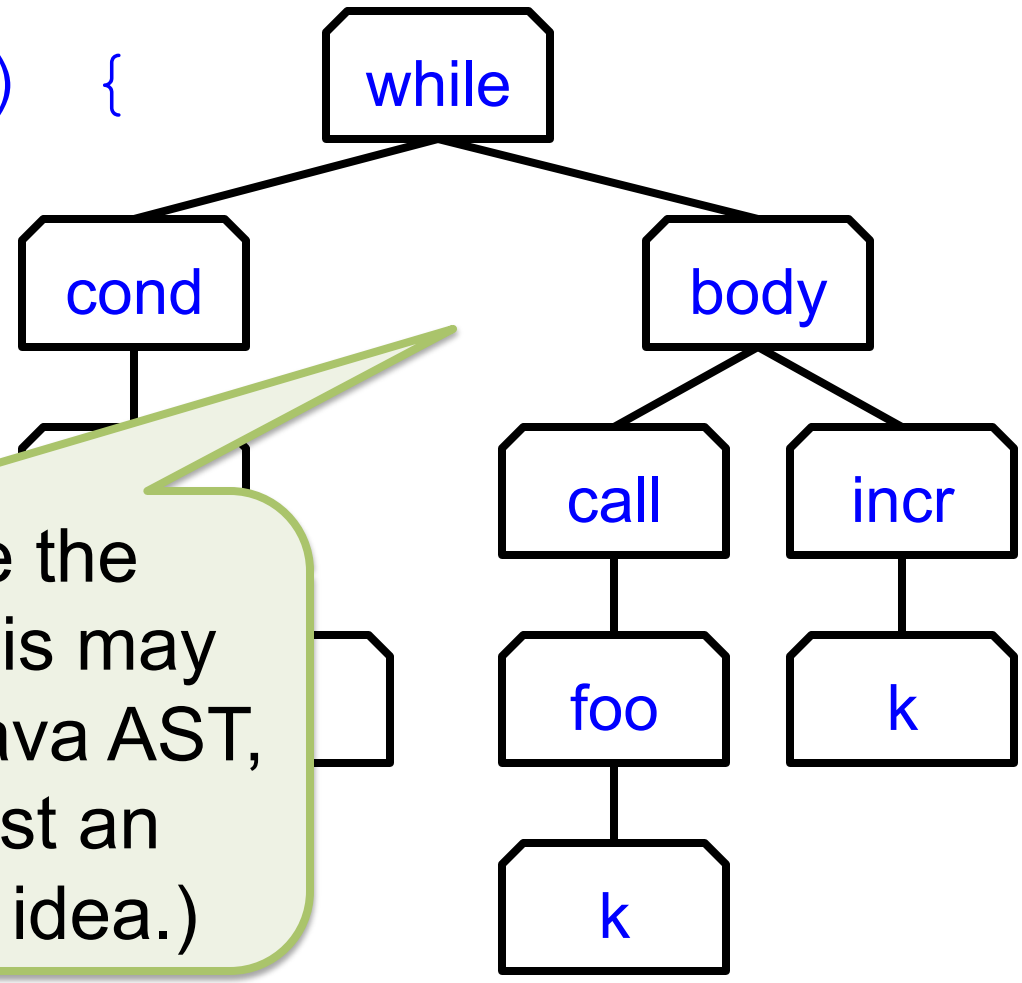
Example: A Java Statement

```
while (k < 7) {
   foo(k);
   k++;
}
```



Example: A Java Statement

```
while (k < 7) {
   foo(k);
   k++;
}
```



You should see the connections! (This may not be an *actual* Java AST, however; it is just an illustration of the idea.)

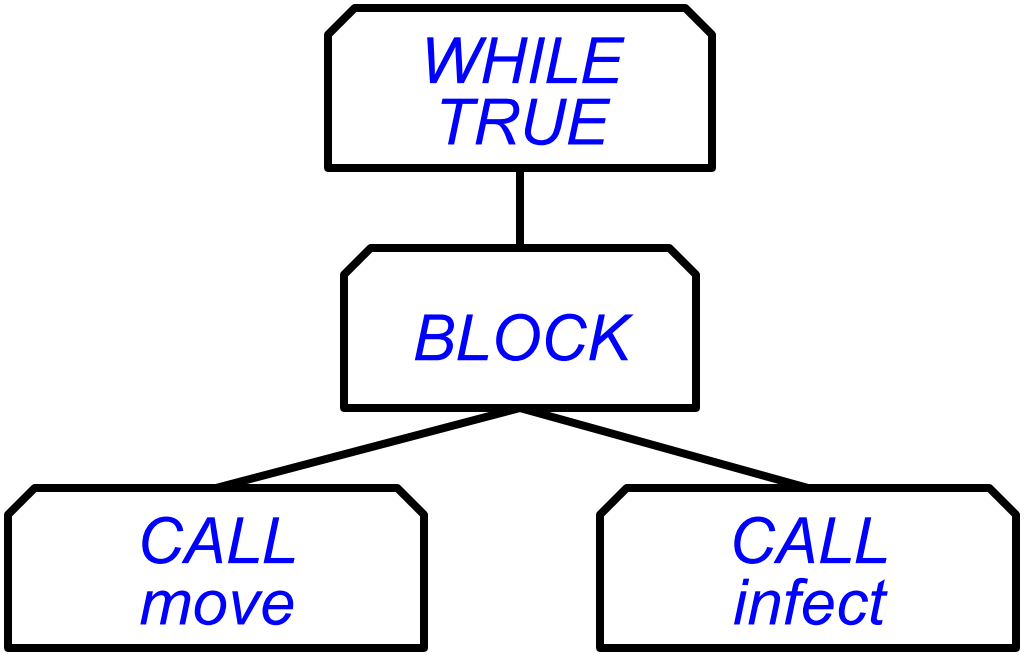
Example: A BL Statement

WHILE true DO

move

infect

END WHILE



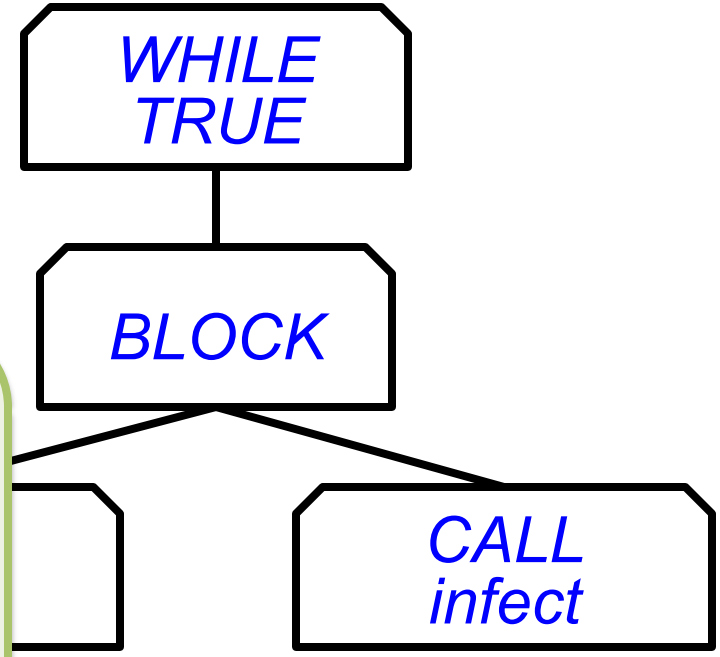
Example: A BL Statement

WHILE true DO

move

infect

END WHILE



You should see the connections! (This is an actual AST for BL; notice it uses a different “design”.)

BL Statement Kinds

instruction

IF test THEN

BLOCK

END IF

IF test THEN

BLOCK

ELSE

BLOCK

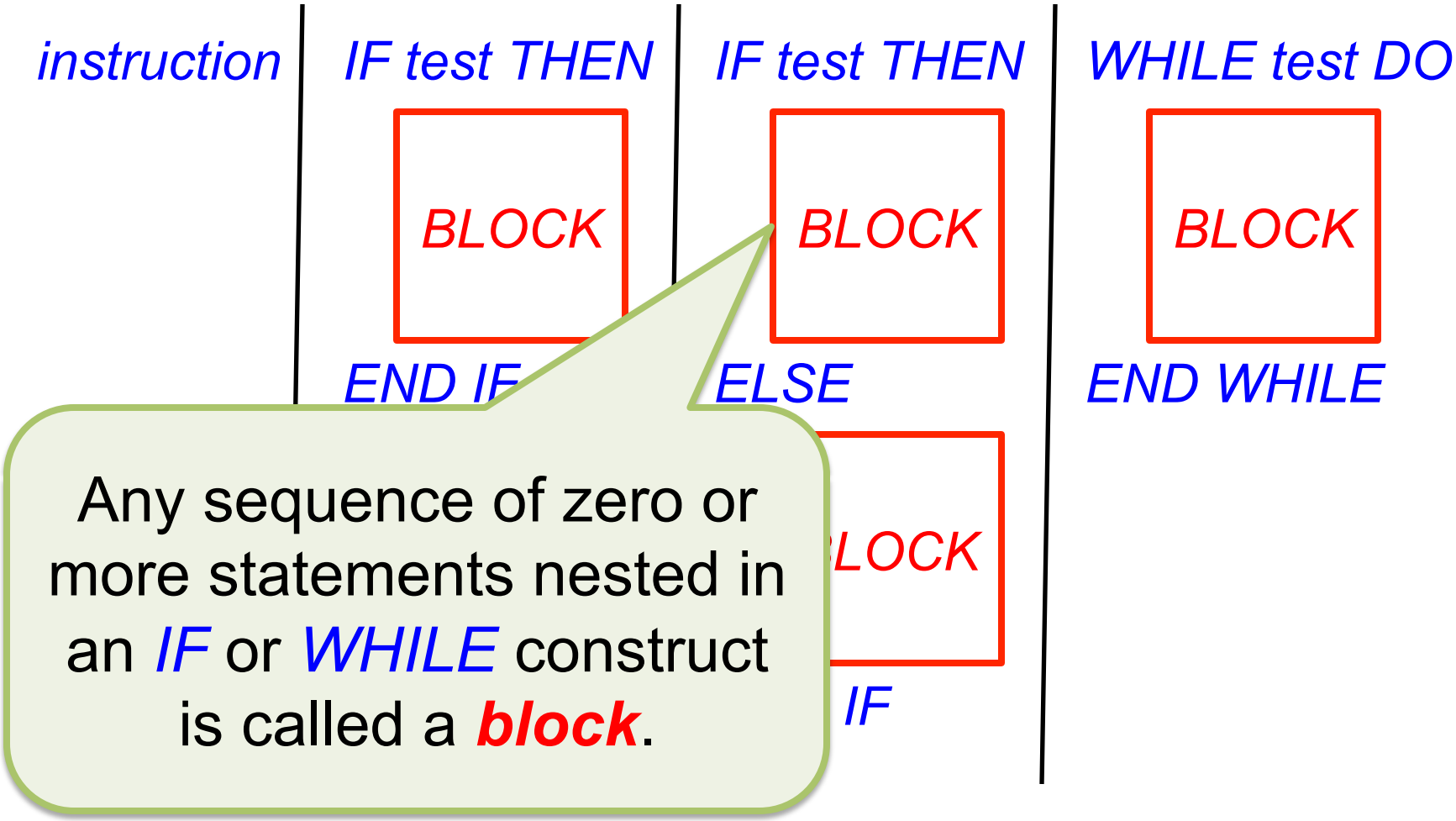
END IF

WHILE test DO

BLOCK

END WHILE

BL Statement Kinds

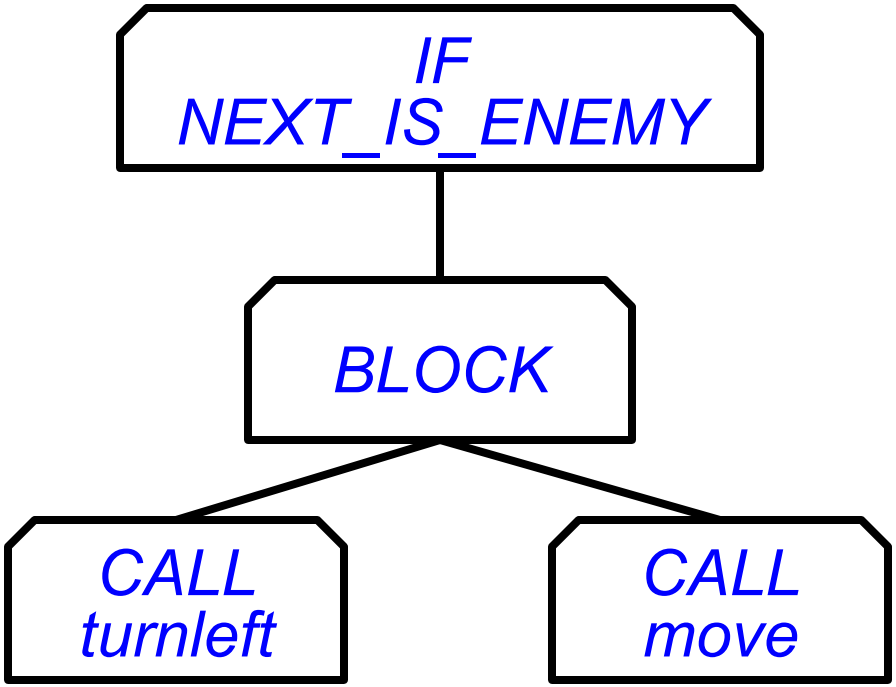


CALL Statement

BL Example	***AST***
turnleft	*CALL* *turnleft*

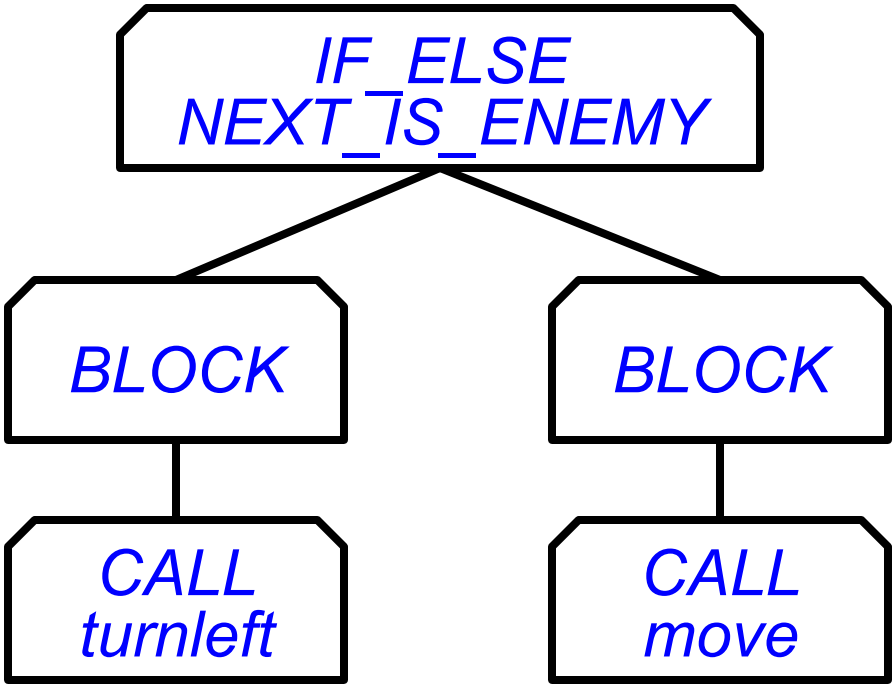
IF Statement

BL Example	***AST***

IF next-is-enemy THEN
turnleft
move
END IF
	

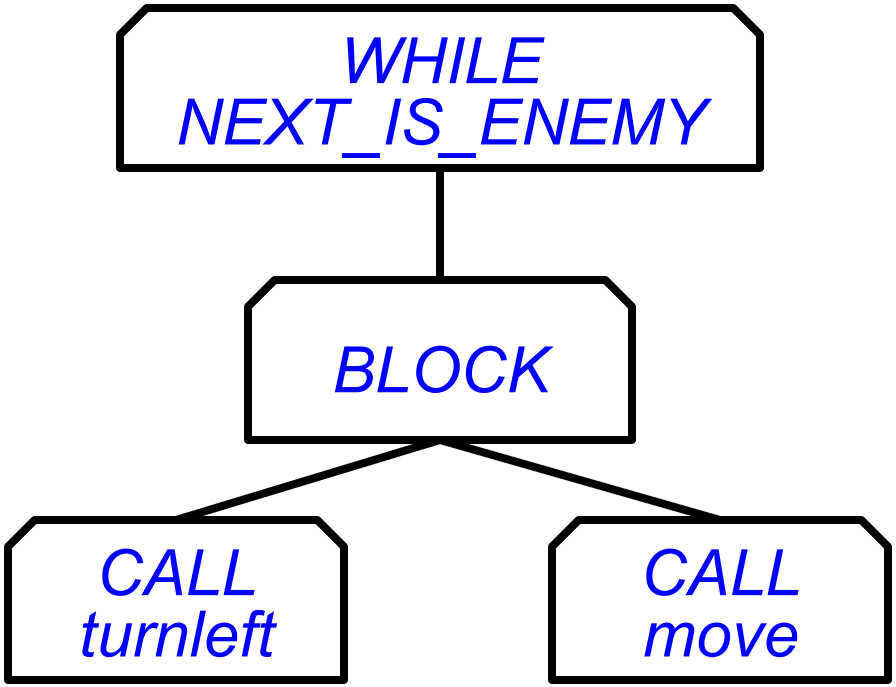
IF_ELSE Statement

BL Example	***AST***

IF next-is-enemy THEN
turnleft
ELSE
move
END IF
	

WHILE Statement

BL Example	***AST***

WHILE next-is-enemy DO
turnleft
move
END WHILE
	

Why *BLOCK*?

- Draw the AST for this BL code with and without the intermediate notion of *BLOCK*:

```
IF next-is-empty THEN
    move
    turnright
ELSE
   infect
END IF
```

Why *BLOCK*?

- Draw the AST for t
  without the interme

```
IF next-is-empty THEN
    move
    turnright
ELSE
   infect
END IF
```

If it's not clear, draw the AST for this code with and without *BLOCK*:

```
IF next-is-empty THEN
    move
ELSE
    turnright
    infect
END IF
```

AST Node Labels

- An AST for BL is a ***`tree of`*** ... what?
- Each node has *some* of the following:
  - The ***kind*** of statement (e.g., *BLOCK*, *WHILE*)
  - The ***test*** condition (e.g., *NEXT_IS_EMPTY*, *TRUE*)
  - The ***call*** of an instruction (e.g., *infect*, *move*), realizing that this may be an instruction defined elsewhere in the program (e.g., *FindObstacle* in an earlier BL example)

This mathematical 3-tuple of information (of which either ***test*** or ***call*** might be relevant, depending on the ***kind***) will be called a `STATEMENT_LABEL`.

t?

g:

- The ***kind*** of statement (e.g., *BLOCK*, *WHILE*)
- The ***test*** condition (e.g., *NEXT_IS_EMPTY*, *TRUE*)
- The ***call*** of an instruction (e.g., *infect*, *move*), realizing that this may be an instruction defined elsewhere in the program (e.g., *FindObstacle* in an earlier BL example)

The mathematical model of an AST for a BL statement is therefore a ***tree of*** *STATEMENT_LABEL*.

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g:

- The ***kind*** of statement (e.g., *BLOCK*, *WHILE*)
- The ***test*** condition (e.g., *NEXT_IS_EMPTY*, *TRUE*)
- The ***call*** of an instruction (e.g., *infect*, *move*), realizing that this may be an instruction defined elsewhere in the program (e.g., *FindObstacle* in an earlier BL example)

Resources

- Wikipedia: Abstract Syntax Tree
  - http://en.wikipedia.org/wiki/Abstract_syntax_tree