Java By Abstraction: Chapter 5

Control Structures

Some examples and/or figures were borrowed (with permission)
from slides prepared by Prof. H. Roumani

Flow of Control

- Previous chapters illustrated sequential flow
- Altering execution flow can result in powerful data processing
- Selective flow control:
  - Execution path takes one of many branches
- Iterative flow control:
  - Execution path repeats until a condition is met

Review: Boolean Operators

- Relational: < > <= >= == !=
  - 0 < x < 1 // incorrect, syntax error
  - x > 0 && x < 1 // valid syntax

- Logical NOT: !
- Logical AND: &&
- Logical OR: ||

Lazy (Short-Circuit) Evaluation

- Applies to && and || operators
- Does not evaluate second operand unless necessary

  false && p == false // regardless of value of p

  true || p == true // regardless of value of p

  Thus, p is never evaluated

- Example

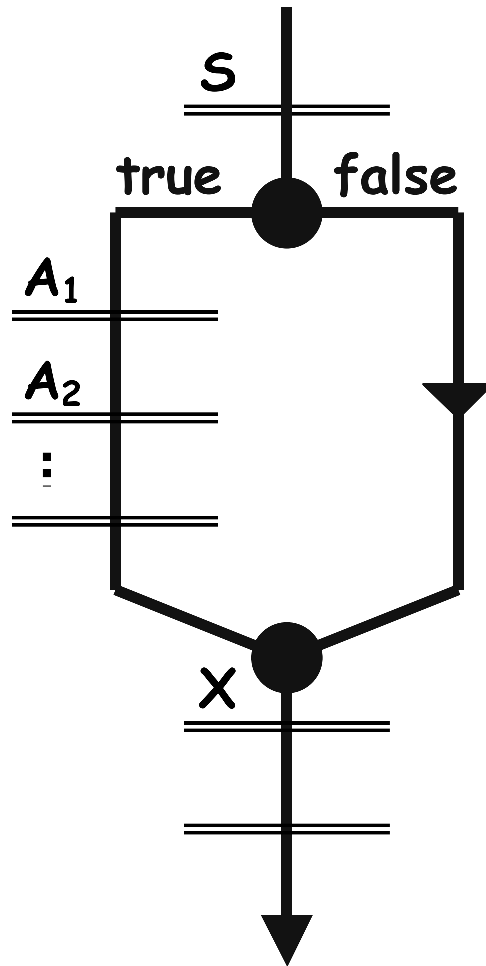
  x.equals(y) // results in exception if x is null

  x != null && x.equals(y) // evaluated iff x is not null

Selection (a.k.a. Branching)

- Involves the evaluation of a Boolean expression
- If the expression evaluates to true, code execution takes a separate path
- In Java, the separate path is enclosed in a code block (indicated by braces)
- If the expression evaluates to false, code execution continues with the statement after the code block

if Statement




```
Statement-S
if (condition)
{
   Statement-A1
   Statement-A2
     ⋮
}
Statement-X
  ⋮
```

Pitfall: Including a Semicolon

- Example

```
int entry = input.nextInt();
int absValue = entry;
if (entry < 0);
{
   absValue = -entry;
}
output.println(absValue);
```

- Consequently, the entry will always be negated

Pitfall: Omission of Braces

- Example

```
if (count > maximum)
        count--;
        output.println("Maximum exceeded.");
```

- Count will be decremented if the condition is true
- Print statement will be executed regardless

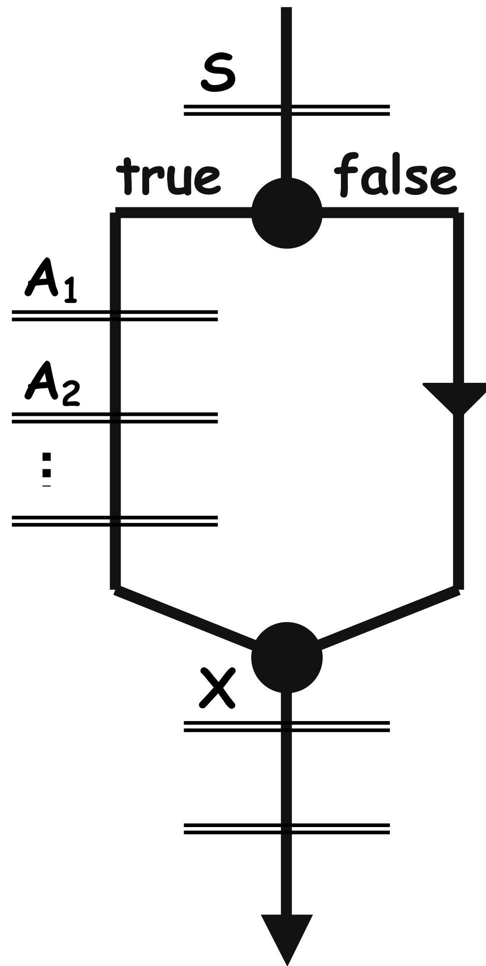
Pitfall: Variable out of Scope

- Variables declared in a code block are accessible only within that block
- Example

```
if (entry < 0)
{
  int absValue = -entry;
}
output.println(absValue);
```

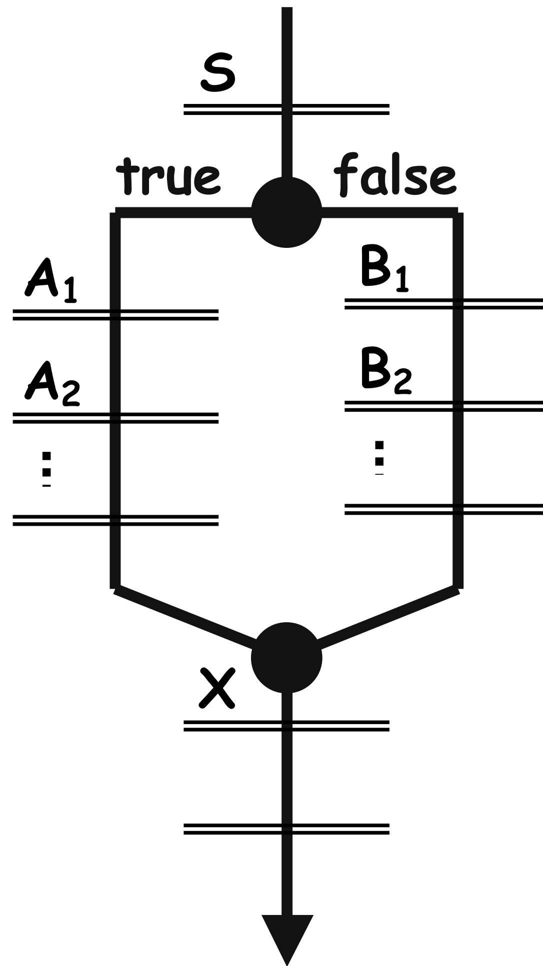
- Variable absValue is not accessible outside the block
- Results in a compile time error

if Statement (Recall)




```
Statement-S
if (condition)
{
    Statement-A1
    Statement-A2
      ⋮
}
Statement-X
  ⋮
```

if-else Statement



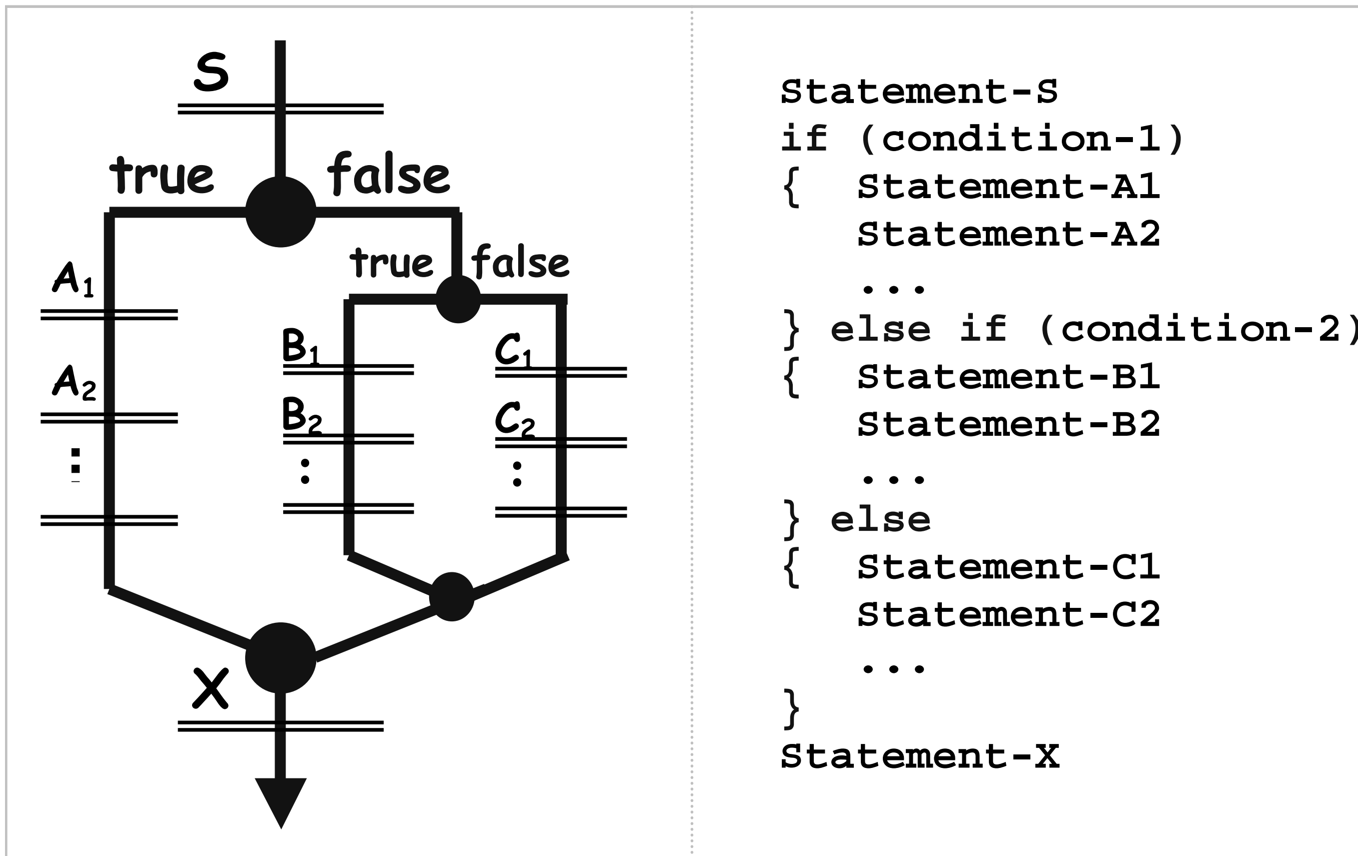

```
Statement-S
if (condition)
{
   Statement-A1
   Statement-A2
   ...
} else
{
   Statement-B1
   Statement-B2
   ...
}
Statement-X
```

if or if-else?

- Beneficial to use “if-else” statements
  - Clearly represents “decision making” choices
  - Aids in debugging logic errors

- Better to use “if” statements if “else” block is empty

Multiple Conditions (if, else-if, else)



Multiple and Nested if Statements

```
if (mark >= 80)
{    grade = 'A';
} else if (mark >= 70)
{    grade = 'B';
} else if (mark >= 60)
{    grade = 'C';
} else if (mark >= 50)
{    grade = 'D';
} else
{    grade = 'F';
}
```

```
if (A)
{  if (B)
     {  ... // S1
     } else
     {  ... // S2
     }
} else
{  if (C)
     {  ... // S3
     } else
     {  ... // S4
     }
}
```

Exercise

- Re-write the nested "if" statements into one "if, else-if, else" structure

```
if (A)
{  if (B)
     {  ... // S1
     } else
     {  ... // S2
     }
} else
{  if (C)
     {  ... // S3
     } else
     {  ... // S4
     }
}
```

switch Statement

```
switch (intVar)
{   case value1:
        ... // S1
        break;
    case value2 value3:
        ... // S2
        break;
    default:
        ... // S3
        break;
}
```

```
if (intVar == value1)
{   … // S1
} else if (intVar == value2
||
        intVar == value3)
{   … // S2
} else
{   … // S3
}
```

Iteration

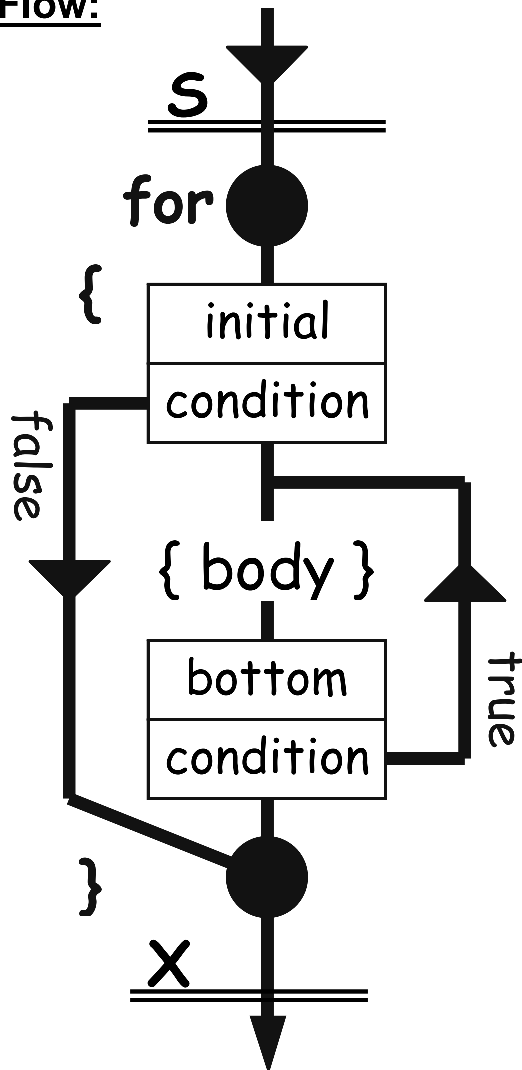
- Computer can execute millions of instructions in a second
- But, programmers don't need to specify each instruction individually
- Iteration allows a block of code to be executed repeatedly
- Accomplished using loop structure

for Loop

- Loop body
  - Statements to be executed iteratively (i.e., to be looped)
- Initialization statement (optional)
  - Executed once, when the loop is first encountered
  - Used to declare and/or initialize any variables use within the loop body (be careful of variable scope)
- Boolean condition to continue iteration (i.e., looping)
  - Similar to the if-statement condition
  - Loop body is executed if the condition holds (i.e., is true)
- Update statement (optional)
  - Update variables/state at the end of each iteration (i.e., loop)

for Loop

Flow:



Syntax:

```
Statement-S
for (initial; condition; bottom)
{
   body;
}
Statement-X
```

Algorithm:

1. Start the `for` scope
2. Execute `initial`
3. If `condition` is `false` go to `9`
4. Start the body scope `{`
5. Execute the body
6. End the body scope `}`
7. Execute `bottom`
8. If `condition` is `true` go to `4`
9. End the `for` scope

Example

- Output the numbers from 1..100
- Sequential

```
System.out.println("1");
System.out.println("2");
System.out.println("3");
…
```

- Iterative

```
final int MAX = 100;
for (int count = 1; count <= MAX; count++)
{
   System.out.println(count);
}
```

Importance of Loop Condition

- Can be as simple or complex as necessary
- If false before first iteration, loop skipped
- If always true, loop continues indefinitely

Sentinel-Based Input

- Sentinel: a value used to signal the end of input
- Task:
  - Read-in positive integers as input
  - Input -1 to signal end of input
  - Output sum of inputs

- (Code to be written as a group in lecture)

Friendly Input Validation

```
…
output.print("Enter a positive integer: ");
int n;
for (n = input.nextInt(); n <=0; n = input.nextInt())
{
   output.print("Invalid! Please retry: ");
}
...
```

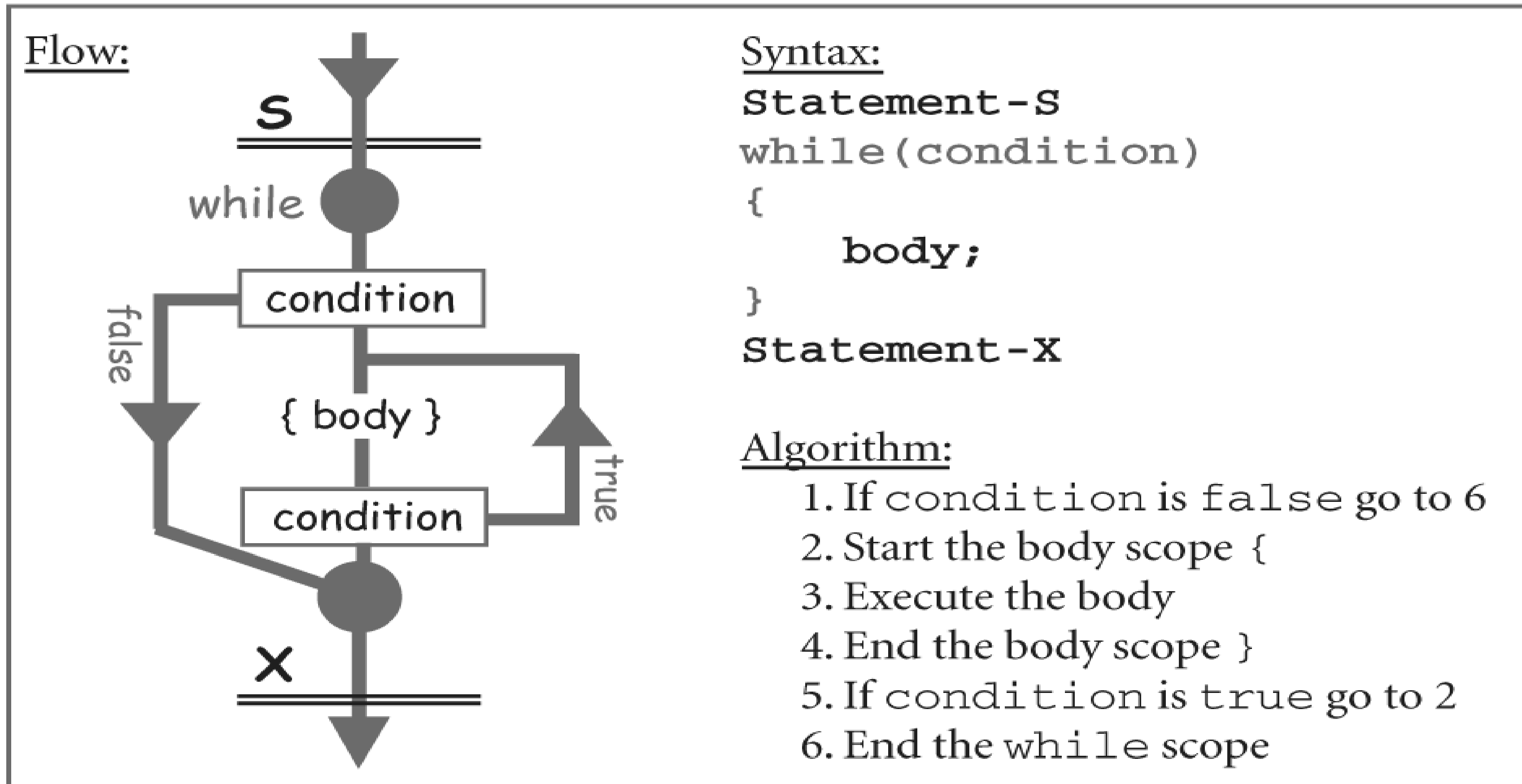
Nested Loops

```
final int M = 5;
final int N = 3;
for (int i = 0; i < M; i++)
{
   for (int j = 0; j < N; j++)
   {
         output.println("" + i + " " + j);
   }
}
```

Output (p. 195):

```
0 0
0 1
0 2
1 0
1 1
1 2
2 0
…
```

while Loop



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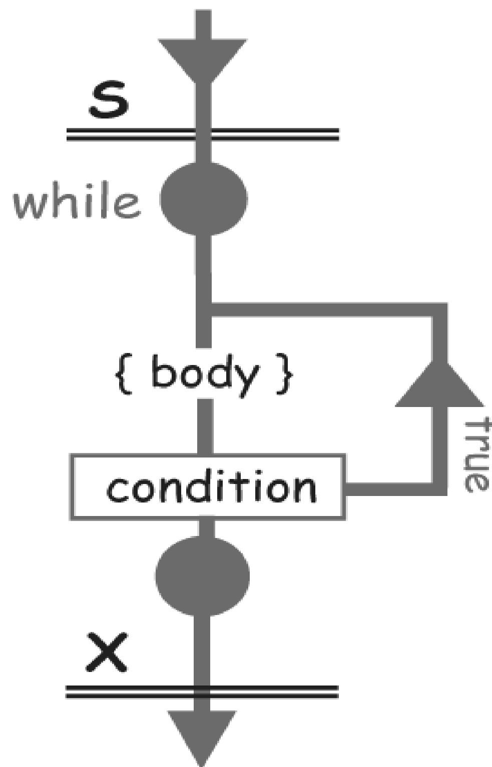
do-while Loop

Flow:



Syntax:

```
Statement-S
do
{
    body;
}
while (condition)
Statement-X
```

Algorithm:

1. Start the body scope {
2. Execute the body
3. End the body scope }
4. If `condition` is `true` go to 1
5. End the `while` scope

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Lots of Loops

- while ↔ for:

```
while (condition)
{
    …
}

for (; condition; )
{
    …
}
```

- do-while ↔ for:

```
do
{
    …
} while (condition);

for (boolean b = true; b; b = condition)
{
    …
}
```

File Input/Output

- I/O from user:
  - Scanner input = new Scanner(System.in);
  - PrintStream output = new PrintStream(System.out);

- I/O from a file:
  - Scanner fileInput = new Scanner(new File(“log.txt”);
  - PrintStream fileOutput = new PrintStream(“log.txt”);