

COMP 110/L Lecture 14

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Outline

- **Loops**
 - `while`
 - `for`
 - `do...while`
- **Shorthand variable updates**

Loops

Motivation

Some computations need to be performed multiple times

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Question: given only $+$, how can $*$ be implemented?

$$3 * 4$$

-High level question – forget code for a moment

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$$12$$

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Question: given only $+$, how can $*$ be implemented?

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$$3 + 3 + 3 + 3 \text{ (or } 4 + 4 + 4)$$

$$12$$

$$A * B$$

Motivation

Some computations need to be performed multiple times

Question: given only $+$, how can $*$ be implemented?

$$\begin{array}{c} 3 * 4 \\ 3 + 3 + 3 + 3 \text{ (or } 4 + 4 + 4) \\ 12 \end{array}$$

$$A * B$$

**Add A to itself B times
(with some extra rules)**

- High level question – forget code for a moment
- Extra rules: handling negative values and 0

-We can define a method signature for this

```
public static int  
multiply(int a, int b) {  
    ...  
}
```

-We can define a method signature for this

```
public static int
multiply(int a, int b) {
    switch (b) {
        case 0:
            return 0;
        case 1:
            return a;
        case 2:
            return a + a;
        case 3:
            return a + a + a;
        ...
    }
}
```

-We can sorta define it, but this clearly isn't going to work in general. We'd have literally billions of cases.

Enter while

Intuition: while a condition is true, execute the given code.

Condition checked, all code executed, condition checked...

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```
int x = 0;
while (x < 10) {
    System.out.println(x);
    x = x + 1;
}
```

Example:

```
WhileXLessThan10.java
```

Revisiting Multiplication:

`MultiplyWithWhile.java`

while Caveat

Counterintuitively, it does **not** exactly mean:
“while condition is true”

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```
int x = 0;
while (x < 5) {
    System.out.println("hi");
    x = 10;
    System.out.println("bye");
}
```

while Caveat

Counterintuitively, it does **not** exactly mean:
“while condition is true”

```
int x = 0;
while (x < 5) { Condition only checked here
    System.out.println("hi");
    x = 10;
    System.out.println("bye");
}
```

Prints:

hi

bye

-This is so counterintuitive that students generally better understand while loops if they are renamed banana loops

A Pattern Emerges

- Many loops commonly:
 - Do some sort of initialization
 - Check some sort of condition
 - Update some variables on each iteration
- Special type of loop for this: `for`

for Loops

for Loops

```
int x = 0;
while (x < 10) {
    System.out.println(x);
    x = x + 1;
}
```

for Loops

```
int x = 0; Initialization
while (x < 10) {
    System.out.println(x);
    x = x + 1;
}
```

for Loops

```
int x = 0; Initialization  
while (x < 10) { Condition check  
    System.out.println(x);  
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```
int x = 0; Initialization  
while (x < 10) { Condition check  
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for Loops

```
int x = 0; Initialization  
while (x < 10) { Condition check  
    System.out.println(x);  
    x = x + 1; Variable update  
}
```

```
for (int x = 0; x < 10; x = x + 1) {  
    System.out.println(x);  
}
```

-The equivalent for loop

for Loops

```
int x = 0; Initialization  
while (x < 10) { Condition check  
    System.out.println(x);  
    x = x + 1; Variable update  
}
```

Initialization

```
for (int x = 0; x < 10; x = x + 1) {  
    System.out.println(x);  
}
```

-The equivalent for loop

for Loops

```
int x = 0; Initialization  
while (x < 10) { Condition check  
    System.out.println(x);  
    x = x + 1; Variable update  
}
```

Initialization

Condition check

```
for (int x = 0; x < 10; x = x + 1) {  
    System.out.println(x);  
}
```

-The equivalent for loop

for Loops

```
int x = 0; Initialization  
while (x < 10) { Condition check  
    System.out.println(x);  
    x = x + 1; Variable update  
}
```

Initialization	Condition check	Variable update
<pre>for (int x = 0; x < 10; x = x + 1) { System.out.println(x); }</pre>		

-The equivalent for loop

Example:

`ForXLessThan10.java`

Revisiting Multiplication:

`MultiplyWithFor.java`

Same Condition Caveat

Condition is only checked at the start of the loop.

Increment is only done at the end of the loop.

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for (int x = 0; x < 5;) {  
    System.out.println("hi");  
    x = 10;  
    System.out.println("bye");  
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Same Condition Caveat

Condition is only checked at the start of the loop.

Increment is only done at the end of the loop.

Condition only checked here

```
for (int x = 0; x < 5;) {  
    System.out.println("hi");  
    x = 10;  
    System.out.println("bye");  
}
```

Prints:

hi

bye

for vs. while

- Sometimes `for` is more appropriate, sometimes `while`
- Depends on what you need
- Either will work in any situation where a loop is needed

do . . . while Loops

Like a `while` loop, but the condition is checked at the end.

`do . . . while` always executes at least once, unlike `while`.

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`do . . . while` always executes at least once, unlike `while`.

```
int x = 0;
do {
    System.out.println(x);
    x = x + 1;
} while (x < 10);
```

Example:

```
DoWhileXLessThan10.java
```

Multiplication with do . . . while

Conversion to do . . . while would be **incorrect**

Multiplication with do...while

Conversion to do...while would be **incorrect**

```
public static int  
multiply(int a, int b) {  
    int result = 0;  
    while (b > 0) {  
        result = result + a;  
        b = b - 1;  
    }  
    return result;  
}
```


Multiplication with do...while

Conversion to do...while would be **incorrect**

```
public static int  
multiply(int a, int b) {  
    int result = 0; Won't be true  
    while (b > 0) { if b initially was 0  
        result = result + a;  
        b = b - 1;  
    }  
    return result;  
}
```

Shorthand Variable Updates

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We very often update variables in loops

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```
x = x + 1;  
b = b - 1;  
result = result + a;
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```
x = x + 1;  
b = b - 1;  
result = result + a;
```

```
x++ OR ++x  
b-- OR --b  
result += a;
```

- x++ returns the current value of x then increments it later
- ++x increments x and then returns the incremented value
- Same reasoning applies for b-- OR --b

Motivation

We very often update variables in loops

```
x = x + 1;  
b = b - 1;  
result = result + a;
```

```
x++ OR ++x  
b-- OR --b  
result += a;
```

Saves some typing, very commonly used.

- x++ returns the current value of x then increments it later
- ++x increments x and then returns the incremented value
- Same reasoning applies for b-- OR --b