CS 106A, Lecture 6
Control Flow and Parameters

suggested reading:
Java Ch. 5.1-5.4

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Based on slides created by Keith Schwarz, Mehran Sahami, Eric Roberts, Stuart Reges, and others.

Plan For Today

- Announcements
- Recap: If and While in Java
- For Loops in Java
- Methods in Java
- Scope

HW2 Cutoff

- Parameters

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Conditions in Java

```
while(condition) {
    body
}
```

```
if(condition) {
    body
}
```

The condition should be a “boolean” which is either **`true`** or **`false`**

Booleans

$1 < 2$

```
true
```

Relational Operators

Operator	Meaning	Example	Value
==	equals	`1 + 1 == 2`	`true`
!=	does not equal	`3.2 != 2.5`	`true`
<	less than	`10 < 5`	`false`
>	greater than	`10 > 5`	`true`
<=	less than or equal to	`126 <= 100`	`false`
>=	greater than or equal to	`5.0 >= 5.0`	`true`

* All have equal precedence

Relational Operators

```
if (1 < 2) {
     println("1 is less than 2!");
}
```

```
int num = readInt("Enter a number: ");
if (num == 0) {
     println("That number is 0!");
} else {
     println("That number is not 0.");
}
```

Practice: Sentinel Loops

- **sentinel**: A value that signals the end of user input.
  - **sentinel loop**: Repeats until a sentinel value is seen.

- Example: Write a program that prompts the user for numbers until the user types -1, then output the sum of the numbers.
  - In this case, -1 is the sentinel value.

```
Type a number: 10
Type a number: 20
Type a number: 30
Type a number: -1
Sum is 60
```

Practice: Sentinel Loops

```
// fencepost problem!
// ask for number - post
// add number to sum - fence


int sum = 0;
int num = readInt("Enter a number: ");
while (num != -1) {
      sum += num;
      num = readInt("Enter a number: ");
}
println("Sum is " + sum);
```

Practice: Sentinel Loops

```
// Solution #2 (ok, but #1 is better)


int sum = 0;
while (true) {
      int num = readInt("Enter a number: ");
      if (num == -1) {
            break;     // immediately exits loop
      }
      sum += num;
}
println("Sum is " + sum);
```

Compound Expressions

In order of precedence:

Operator	Description	Example	Result
!	not	`!(2 == 3)`	`true`
&&	and	`(2 == 3) && (-1 < 5)`	`false`
||	or	`(2 == 3) || (-1 < 5)`	`true`

Cannot "chain" tests as in algebra; use && or || instead

```
// assume x is 15
2 <= x <= 10
true   <= 10
Error!
```

```
// correct version
2 <= x && x <= 10
true   && false
false
```

Boolean Variables

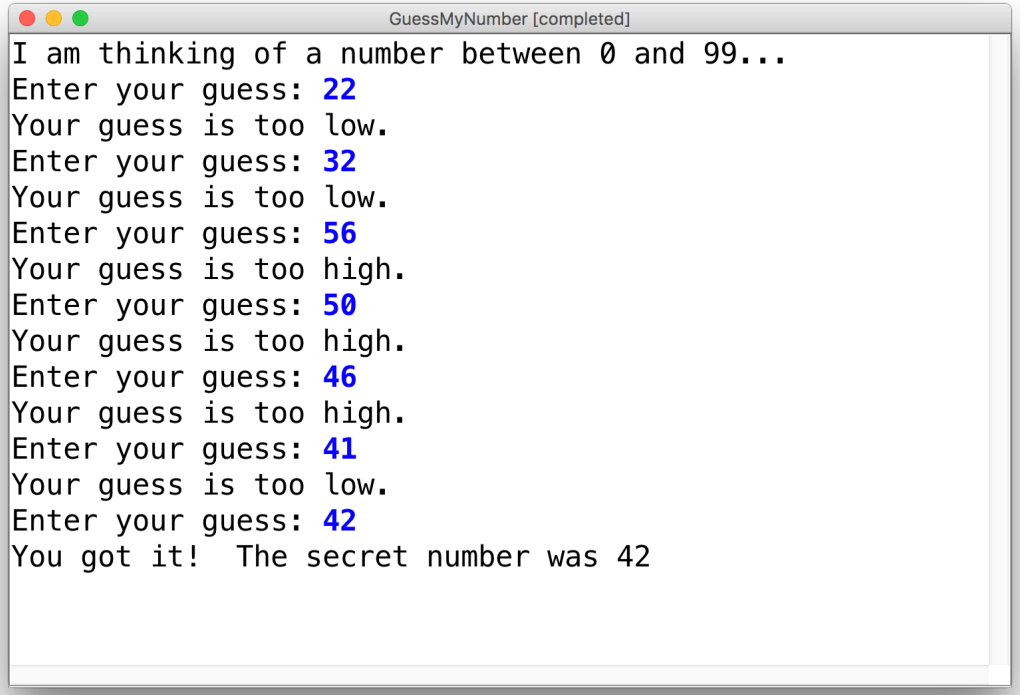
```
// Store expressions that evaluate to true/false
boolean x = 1 < 2;          // true
boolean y = 5.0 == 4.0;     // false

// Directly set to true/false
boolean isFamilyVisiting = true;
boolean isRaining = false;

// Ask the user a true/false (yes/no) question
boolean playAgain = readBoolean("Play again?", "y", "n");
if (playAgain) {
...
```

Practice: GuessMyNumber

- We wrote a program called *GuessMyNumber* that prompts the user for a number until they guess our secret number.
- If a guess is incorrect, the program provides a hint; specifically, whether the guess is too high or too low.



If/Else If/Else

```
if (condition1) {
    ...
} else if (condition2) {        // NEW
    ...
} else {
    ...
}
```

Runs the first group of statements if ***condition1*** is true; otherwise, runs the second group of statements if ***condition2*** is true; otherwise, runs the third group of statements.

You can have multiple else if clauses together.

If/Else If/Else

```
int num = readInt("Enter a number: ");
if (num > 0) {
      println("Your number is positive");
} else if (num < 0) {
      println("Your number is negative");
} else {
      println("Your number is 0");
}
```

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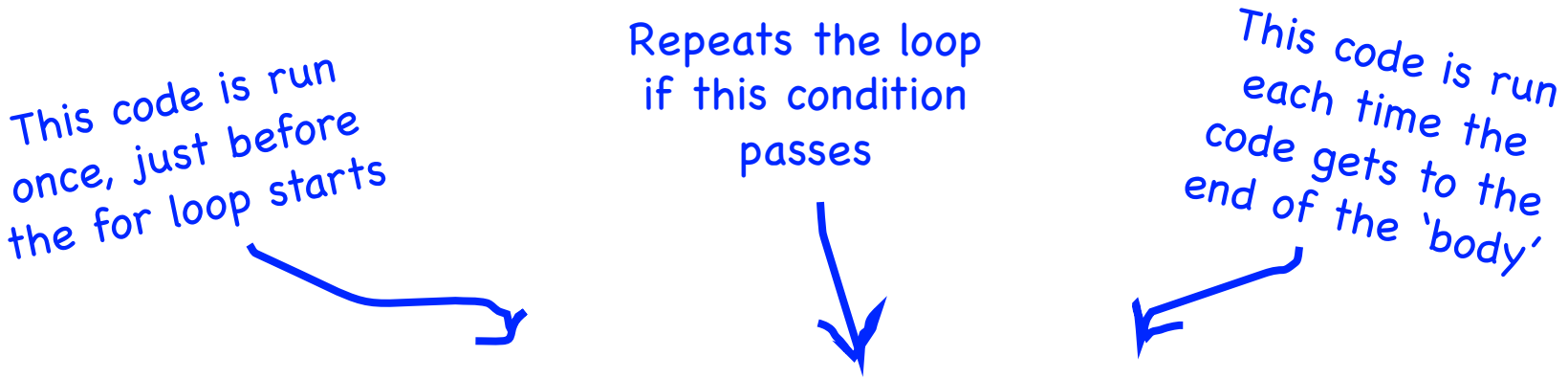
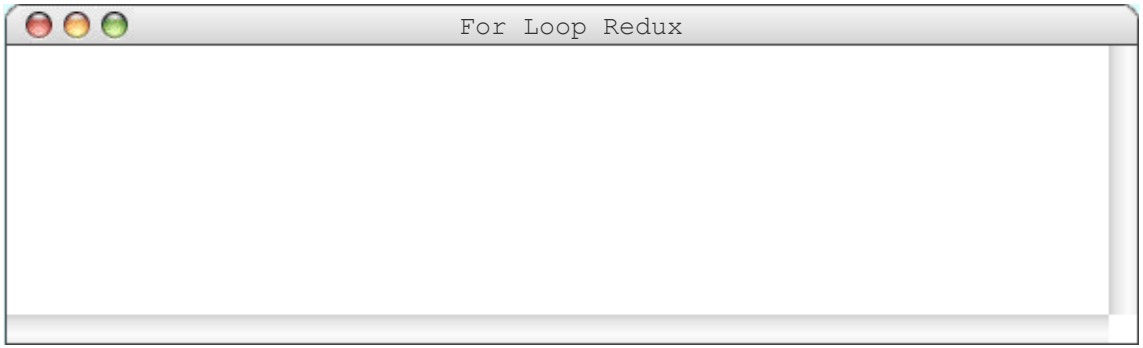
For Loops in Java




```
for (int i = 0; i < 3; i++) {
    println("I love CS 106A!");
}
```

For Loops in Java

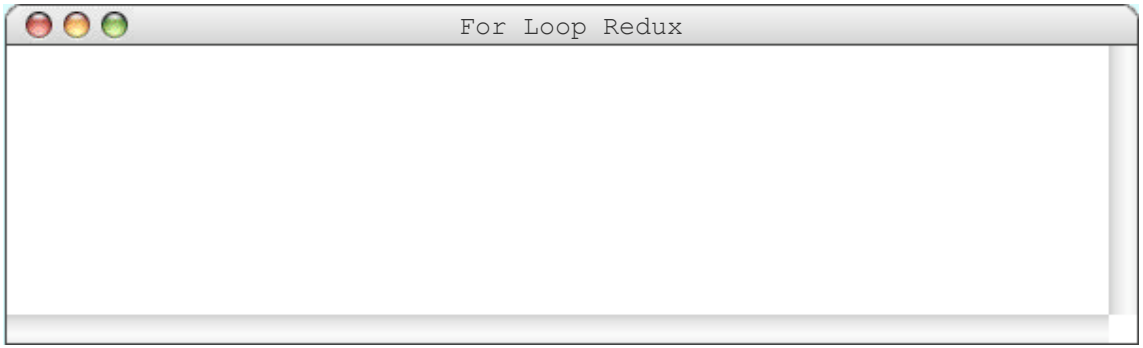
```
for (int i = 0; i < 3; i++) {
    println("I love CS 106A!");
}
```



For Loops in Java

i 0

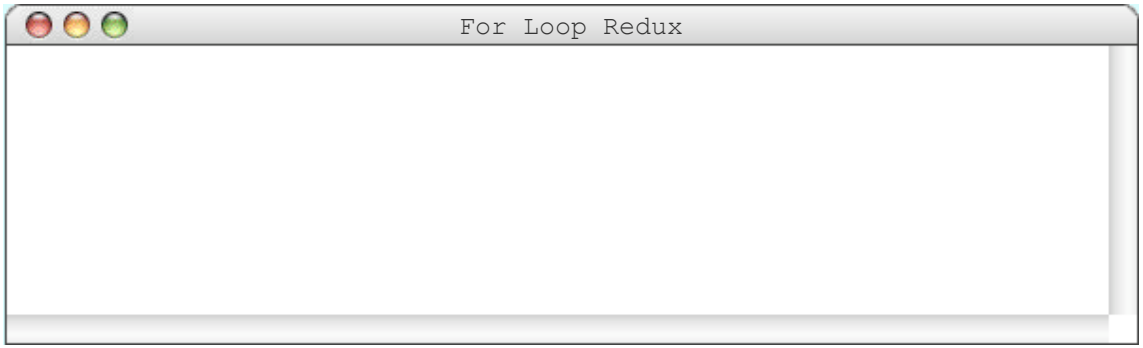
```
for (int i = 0; i < 3; i++) {
    println("I love CS 106A!");
}
```



For Loops in Java

i	0

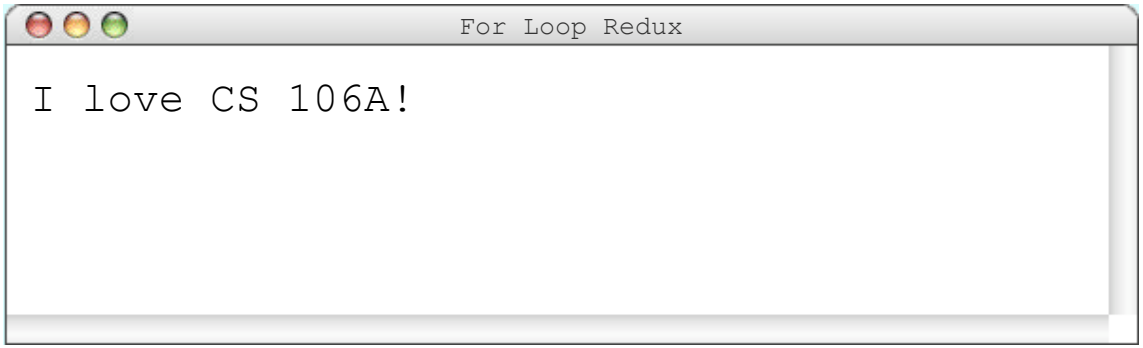
```
for (int i = 0; i < 3; i++) {
    println("I love CS 106A!");
}
```



For Loops in Java

i	0

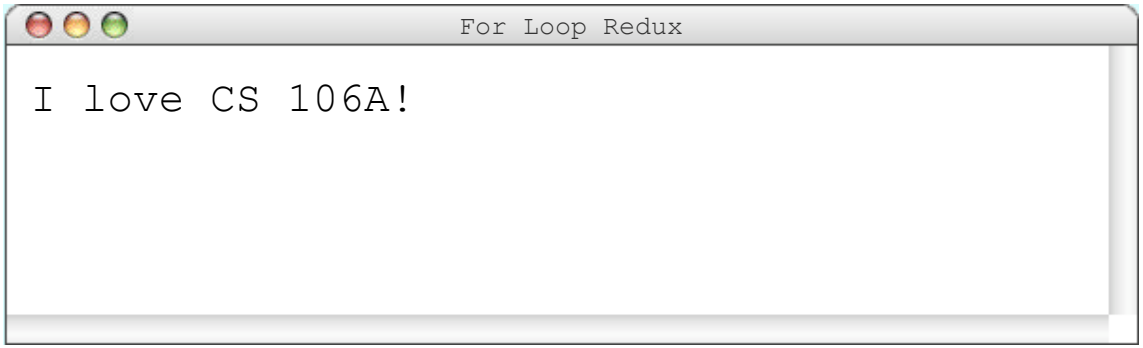
```
for (int i = 0; i < 3; i++) {
    println("I love CS 106A!");
}
```



For Loops in Java

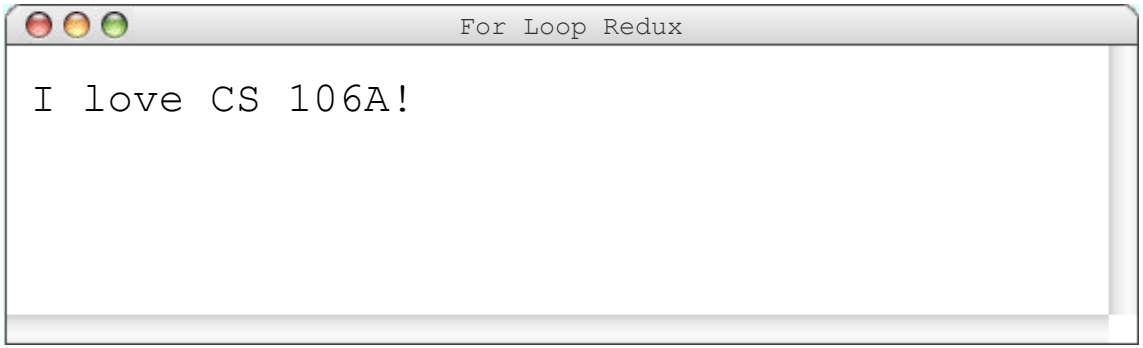
i 0

```
for (int i = 0; i < 3; i++) {
    println("I love CS 106A!");
}
```

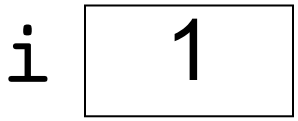


For Loops in Java

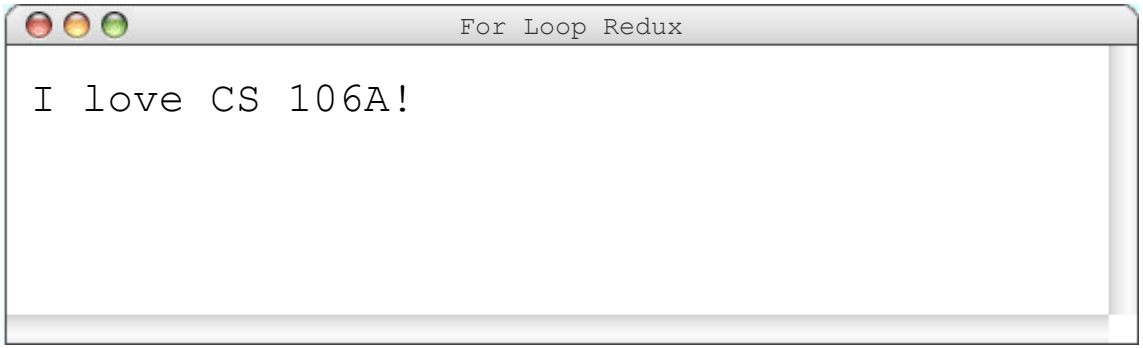
```
for (int i = 0; i < 3; i++) {
    println("I love CS 106A!");
}
```



For Loops in Java



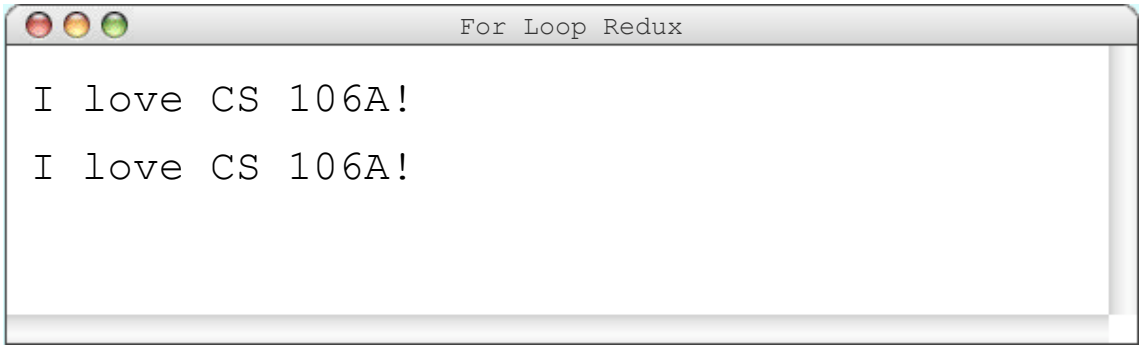

```
for (int i = 0; i < 3; i++) {
    println("I love CS 106A!");
}
```



For Loops in Java

i | 1

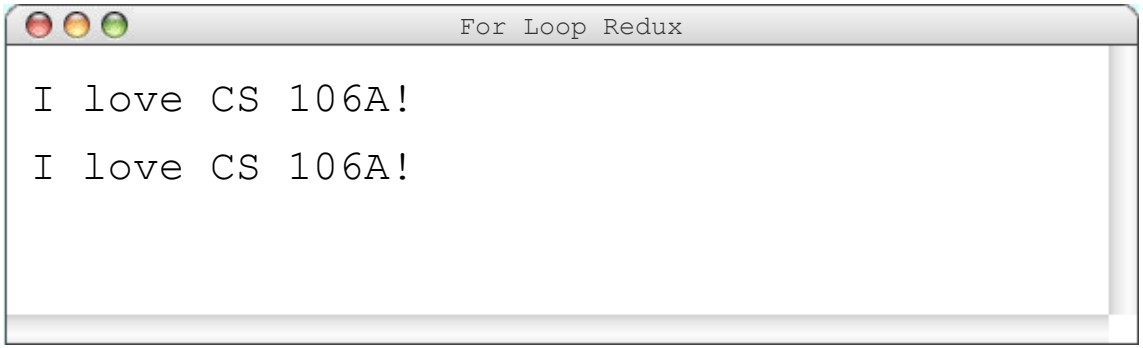
```
for (int i = 0; i < 3; i++) {
    println("I love CS 106A!");
}
```



For Loops in Java

i 2

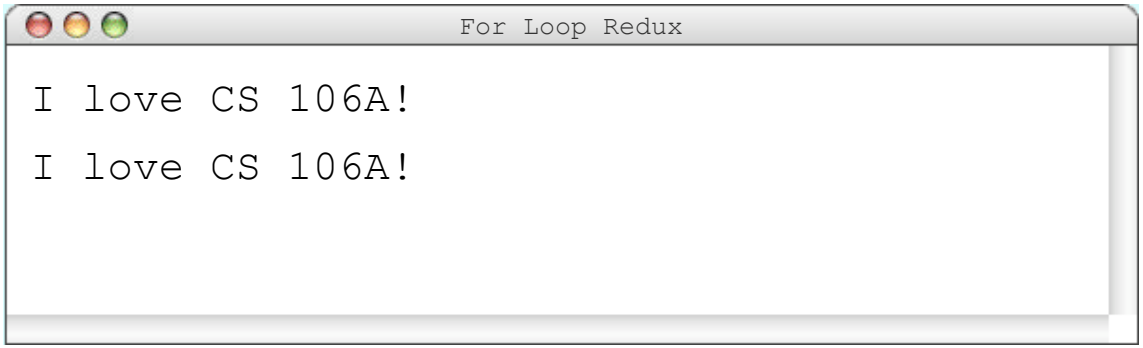
```
for (int i = 0; i < 3; i++) {
    println("I love CS 106A!");
}
```



For Loops in Java

i	2

```
for (int i = 0; i < 3; i++) {
    println("I love CS 106A!");
}
```



For Loops in Java

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}
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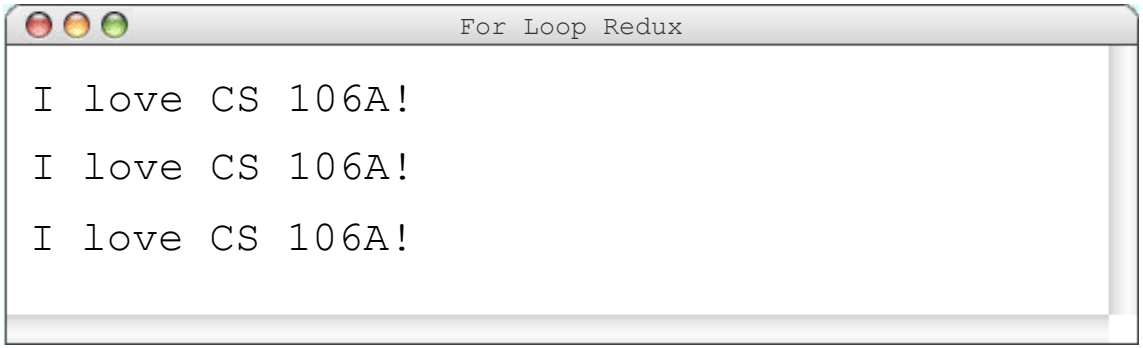

For Loops in Java

i 3

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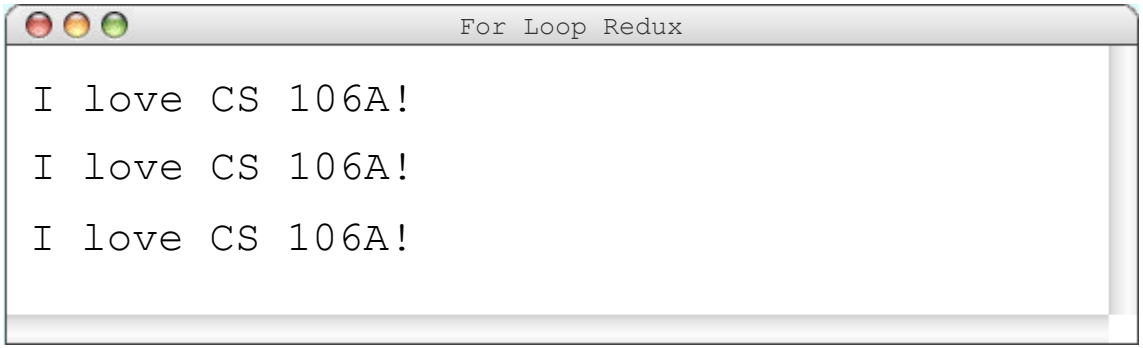
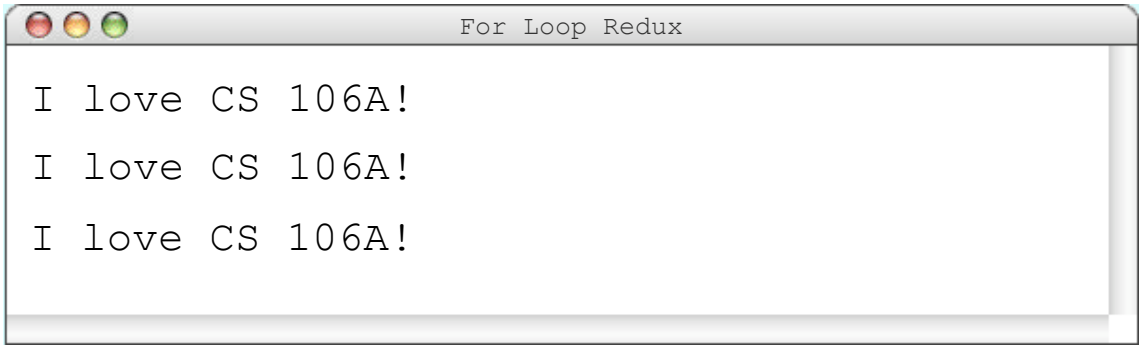
}
```



For Loops in Java

i	3

```
for (int i = 0; i < 3; i++) {
    println("I love CS 106A!");
}
```



For Loops in Java

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}
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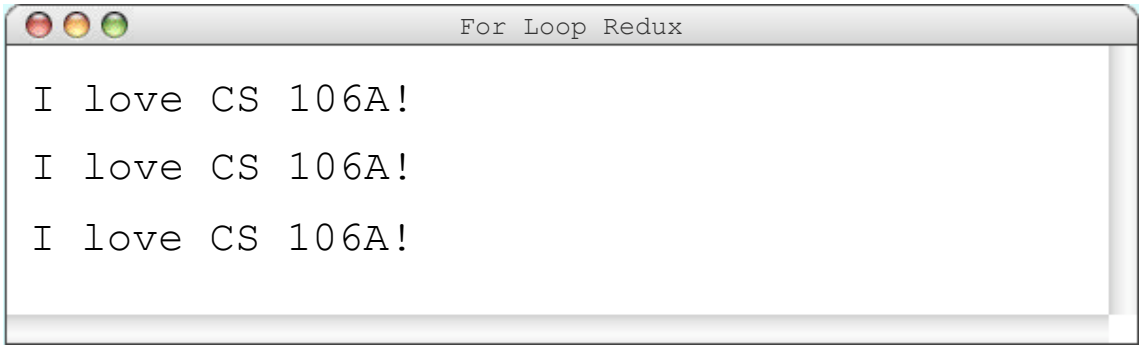

For Loops in Java

```
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}
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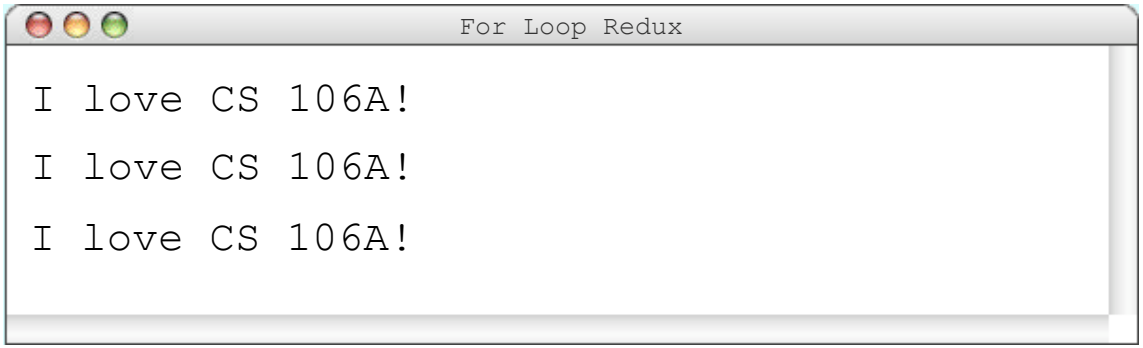

Using the For Loop Variable

```
// prints the first 100 even numbers
for(int i = 1; i <= 100; i++) {
    println(i * 2);
}
```

Using the For Loop Variable

```
// Launch countdown
for(int i = 10; i >= 1; i--) {
    println(i);
}
println("Blast off!");
```

Output:

```
10
9
8
…
Blast off!
```

Using the For Loop Variable

```
// Adds up 1 + 2 + ... + 99 + 100
int sum = 0;
for(int i = 1; i <= 100; i++) {
     sum += i;
}
println("The sum is " + sum);
```

Nested loops

- **nested loop**: A loop placed inside another loop.

```
for (int i = 0; i < 5; i++) {
    for (int j = 0; j < 10; j++) {
        print("*");
    }
    println();   // to end the line
}
```

- Output:

```
**********
**********
**********
**********
**********
```

- The outer loop repeats 5 times; the inner one 10 times.

Nested loop question

- **Q:** What output is produced by the following code?

```
for (int i = 0; i < 5; i++) {
    for (int j = 0; j < i + 1; j++) {
        print("*");
    }
    println();
}
```

A.
```
*****
*****
*****
*****
*****
```

B.
```
*****
****
***
**
*
```

C.
```
*
**
***
****
*****
```

D.
```
1
22
333
4444
55555
```

E.
```
12345
```

(How would you modify the code to produce each output above?)

Nested loop question 2

- How would we produce the following output?

```
....1
...22
..333
.4444
55555
```

Nested loop question 2

- How would we produce the following output?

```
....1
...22
..333
.4444
55555
```

- Answer:

```
for (int i = 0; i < 5; i++) {




}
```

Nested loop question 2

- How would we produce the following output?

```
....1
...22
..333
.4444
55555
```

- Answer:

```
for (int i = 0; i < 5; i++) {
    for (int j = 0; j < 5 - i - 1; j++) {
        print(".");
    }




}
```

Nested loop question 2

- How would we produce the following output?

```
....1
...22
..333
.4444
55555
```

- Answer:

```
for (int i = 0; i < 5; i++) {
    for (int j = 0; j < 5 - i - 1; j++) {
        print(".");
    }
    for (int j = 0; j <= i; j++) {
        print(i + 1);
    }

}
```

Nested loop question 2

- How would we produce the following output?

```
....1
...22
..333
.4444
55555
```

- Answer:

```
for (int i = 0; i < 5; i++) {
    for (int j = 0; j < 5 - i - 1; j++) {
        print(".");
    }
    for (int j = 0; j <= i; j++) {
        print(i + 1);
    }
    println();
}
```

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Defining New Commands in Karel

We can make new commands (or **methods**) for Karel. This lets us *decompose* our program into smaller pieces that are easier to understand.

```
private void name() {
      statement;
      statement;
      ...
}
```

For example:

```
private void turnRight() {
      turnLeft();
      turnLeft();
      turnLeft();
}
```

Methods in Java

We can define new **methods** in Java just like in Karel:

```
private void name() {
      statement;
      statement;
      ...
}
```

For example:

```
private void printGreeting() {
      println("Hello world!");
      println("I hope you have a great day.");
}
```

Methods in Java

```
public void run() {
      int x = 2;
      printX();
}

private void printX() {
      // ERROR!  "Undefined variable x"
      println("X has the value " + x);
}
```

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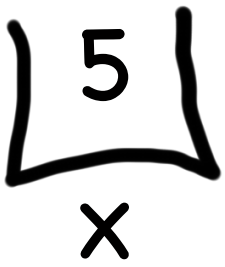
A Variable love story

By Chris Piech

Once upon a time…

...x was looking for love!

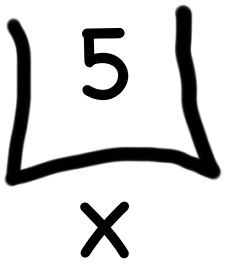
```
int x = 5;
if(lookingForLove()) {
    int y = 5;
}
println(x + y);
```



...x was looking for love!

```
int x = 5;
if(lookingForLove()) {
    int y = 5;
}
println(x + y);
```

x was definitely looking for love



And met y.

```
int x = 5;
if(lookingForLove()) {
    int y = 5;
}
println(x + y);
```

And met y.

```
int x = 5;
if(lookingForLove()) {
    int y = 5;
}
println(x + y);
```

“Wow!”

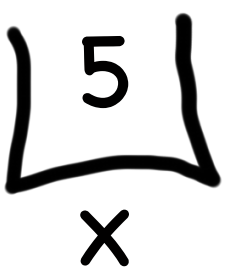
And met y.

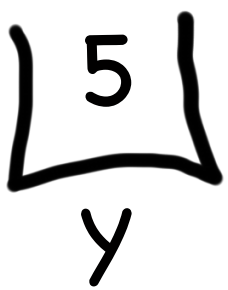
```
int x = 5;
if(lookingForLove()) {
    int y = 5;
}
println(x + y);
```

Wow

And met y.

```
int x = 5;
if(lookingForLove()) {
    int y = 5;
}
println(x + y);
```

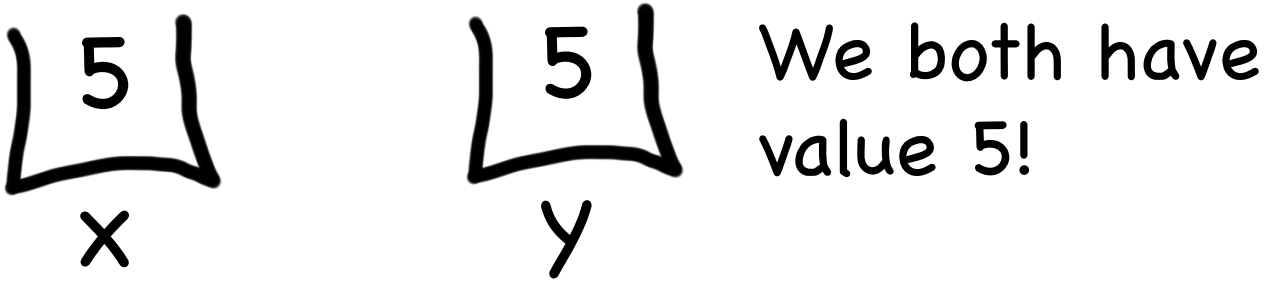




We have so much in common

And met y.

```
int x = 5;
if(lookingForLove()) {
    int y = 5;
}
println(x + y);
```



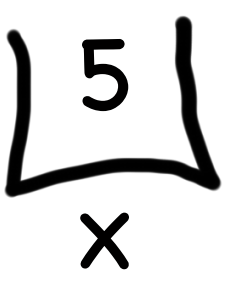
We both have value 5!

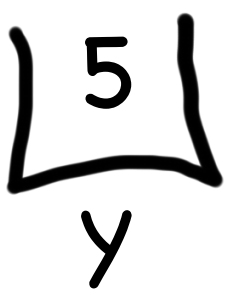
And met y.

```
int x = 5;
if(lookingForLove()) {
    int y = 5;
}
println(x + y);
```

And met y.

```
int x = 5;
if(lookingForLove()) {
    int y = 5;
}
println(x + y);
```





println together?

And met y.

```
int x = 5;
if(lookingForLove()) {
    int y = 5;
}
println(x + y);
```

It was a beautiful match…

…but then tragedy struck.

Tragedy Strikes

```
int x = 5;
if(lookingForLove()) {
    int y = 5;
}
println(x + y);
```

Tragedy Strikes

```
int x = 5;
if(lookingForLove()) {
    int y = 5;
}
println(x + y);
```

Noooooooooooooooo!

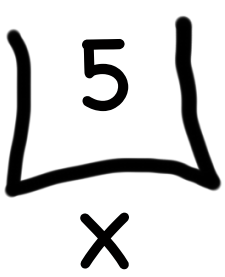
You see…
when a program exits a code block,
all variables declared inside that block go away!

Since y is inside the if-block…

```
int x = 5;
if(lookingForLove()) {
    int y = 5;
}
println(x + y);
```

...it goes away here...

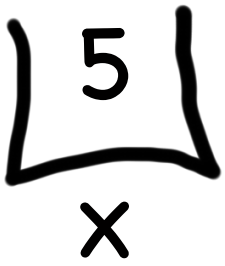
```
int x = 5;
if(lookingForLove()) {
    int y = 5;
}
println(x + y);
```



...and doesn't exist here.

```
int x = 5;
if(lookingForLove()) {
    int y = 5;
}
println(x + y);
```

Error. Undefined variable y.



The End

Sad times ☹

Variable Scope

Variables have a lifetime (called scope):

```
public void run(){
    double v = 8;
    if(condition){
        v = 4;
        … some code
    }
    … some other code
}
```

Variable Scope

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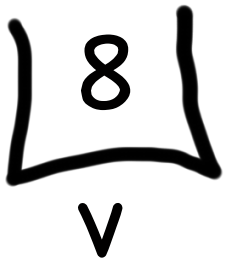
Variables have a lifetime (called scope):

```
public void run(){
    double v = 8;
    if(condition){
        v = 4;
        … some code
    }
    … some other code
}
```

Comes to life here

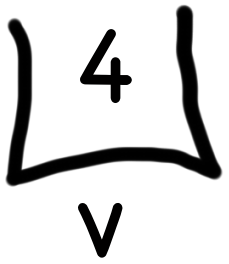


Variable Scope

Variables have a lifetime (called scope):

```
public void run(){
    double v = 8;
    if(condition){
        v = 4;
        … some code
    }
    … some other code
}
```

This is the **inner most** code block in which it was declared….

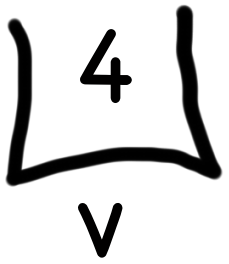


Variable Scope

Variables have a lifetime (called scope):

```
public void run(){
    double v = 8;
    if(condition){
        v = 4;
        … some code
    }
    … some other code
}
```

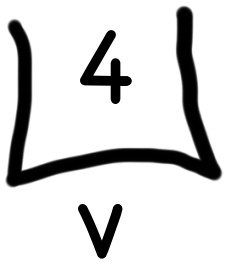
Still alive here…



Variable Scope

Variables have a lifetime (called scope):

```
public void run(){
    double v = 8;
    if(condition){
        v = 4;
        … some code
    }
    … some other code
}
```



It goes away here (at the end of its code block)

Variable Scope

Variables have a lifetime (called scope):

```
public void run(){
    double v = 8;
    if(condition){
        v = 4;
        … some code
    }
    … some other code
}
```

It goes away here (at the end of its code block)

Variable Scope

Variables have a lifetime (called scope):

```
public void run(){
    … some code
    if(condition){
        int w = 4;
        … some code
    }
    … some other code
}
```

This is the scope of **w**

Variable Scope

Variables have a lifetime (called scope):

```
public void run(){
    … some code
    if(condition){
        int w = 4;
        … some code
    }
    … some other code
}
```

w is created here

w goes away here (at the end of its code block)

Variable Scope

```
public void run() {
      int x = 2;
      printX();
}

private void printX() {
      // ERROR!  "Undefined variable x"
      println("X has the value " + x);
}
```

A Variable love story

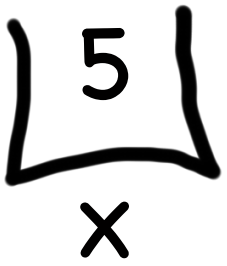
Chapter 2

By Chris

The programmer fixed the bug

...x was looking for love!

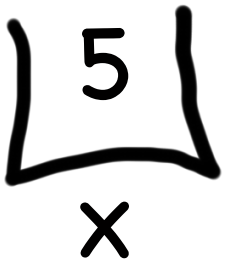
```
int x = 5;
if(lookingForLove()) {
    int y = 5;
    println(x + y);
}
```



...x was looking for love!

```
int x = 5;
if(lookingForLove()) {
    int y = 5;
    println(x + y);
}
```

x was definitely looking for love



And met y.

```
int x = 5;
if(lookingForLove()) {
    int y = 5;
    println(x + y);
}
```

Since they were both "in scope"…

```
int x = 5;
if(lookingForLove()) {
    int y = 5;
    println(x + y);
}
```

…they lived happily ever after.
The end.

Variable Scope

- The **scope** of a variable refers to the section of code where a variable can be accessed.
- **Scope starts** where the variable is declared.
- **Scope ends** at the termination of the code block in which the variable was declared.

- A **code block** is a chunk of code between { } brackets

Variable Scope

You *cannot* have two variables with the same name in the *same scope*.

```
for (int i = 1; i <= 100 * line; i++) {
    int i = 2;                    // ERROR
    print("/");
}
```

Variable Scope

You *can* have two variables with the same name in *different scopes*.

```
private void run() {
    int num = 5;
    cow();
    println(num);
}

private void cow() {
    int num = 10;
    println(num);
}
```

Variable Scope

You *can* have two variables with the same name in *different scopes*.

```
private void run() {
    int num = 5;
    cow();
    println(num);           // prints 5
}

private void cow() {
    int num = 10;
    println(num);           // prints 10
}
```

Variable Scope

You *can* have two variables with the same name in *different scopes*.

```
private void run() {
    int num = 5;
    cow();
    println(num);           // prints 5
}

private void cow() {
    int num = 10;
    println(num);           // prints 10
}
```

Revisiting Sentinel Loops

```
// sum must be outside the while loop!
// Otherwise it will be redeclared many times.
int sum = 0;
int num = readInt("Enter a number: ");
while (num != -1) {
      sum += num;
      num = readInt("Enter a number: ");
}
println("Sum is " + sum);
```

Plan For Today

- Announcements
- Recap: If and While in Java
- For Loops in Java
- Methods in Java
- Scope
- Parameters

Parameters

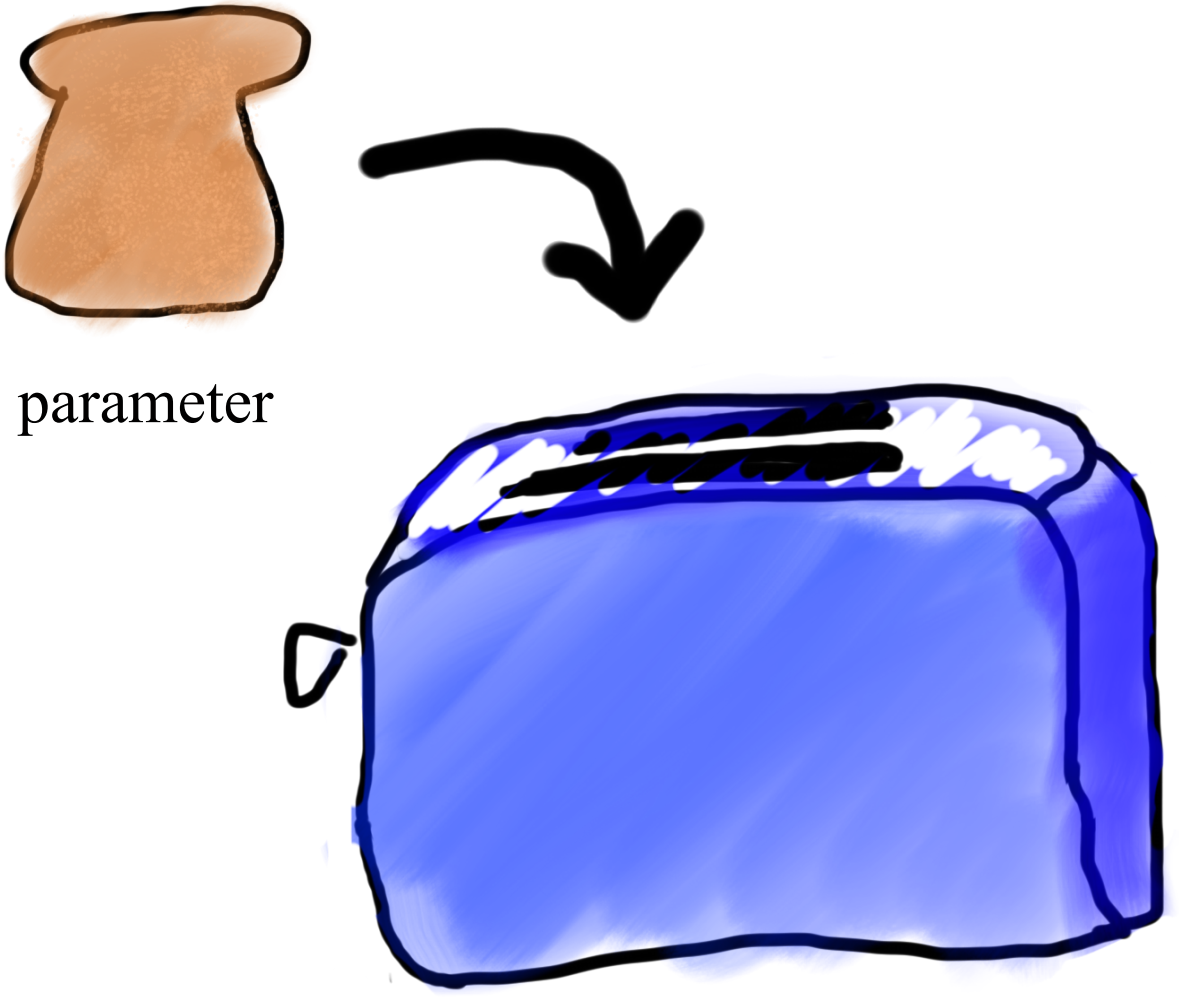
Parameters let you provide a method some information when you are calling it.

Methods = Toasters

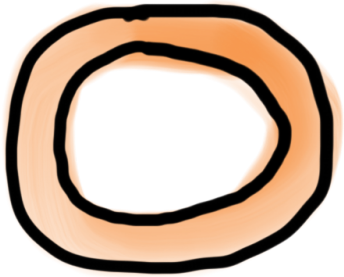
Methods = Toasters

parameter

Methods = Toasters

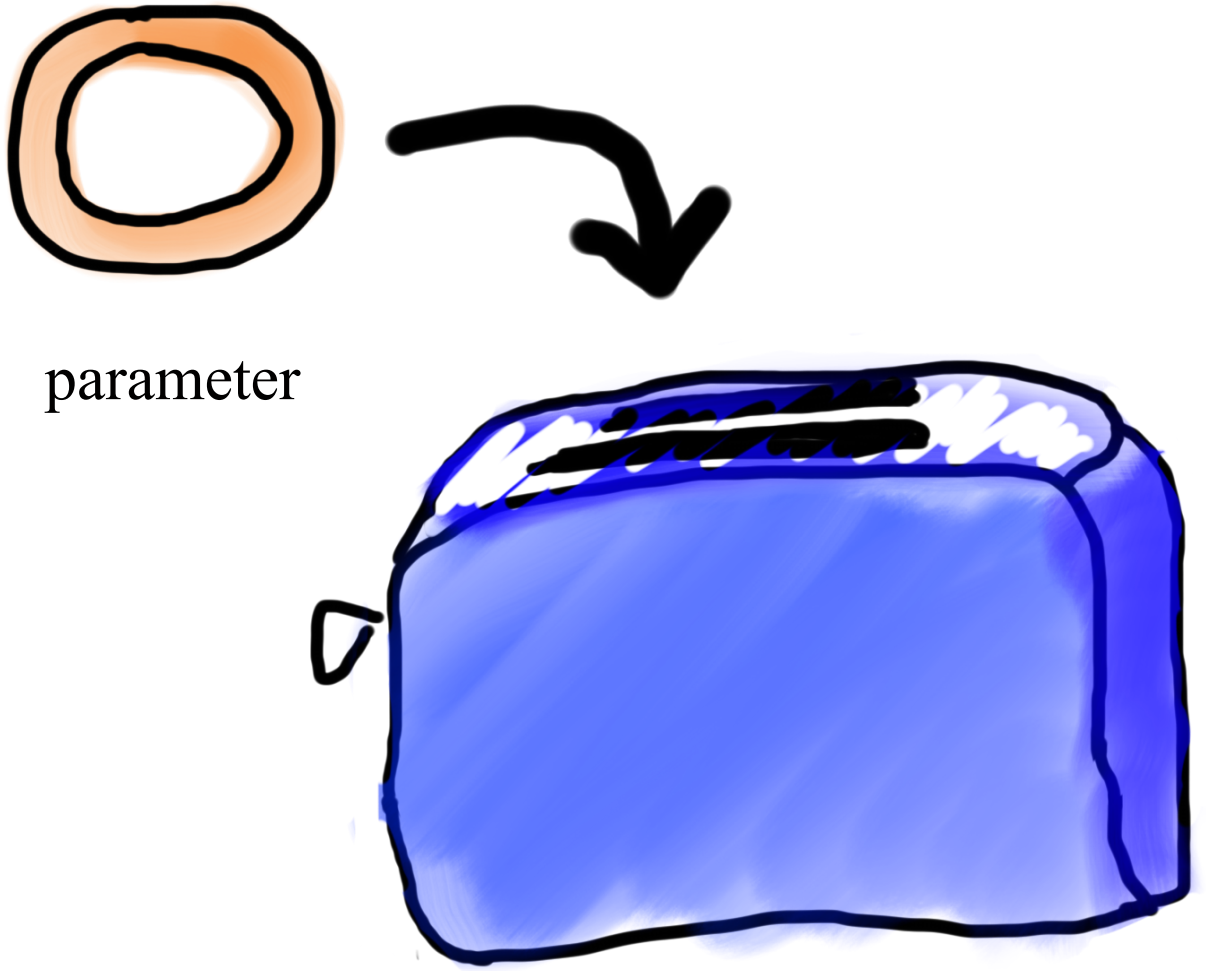


Methods = Toasters

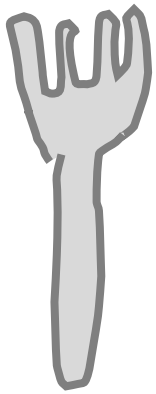


parameter

Methods = Toasters



Methods = Toasters



Invalid parameter

Methods = Toasters

Drawing boxes

- Consider the task of printing the following boxes:

```
**********
*        *
*        *
**********

*******
*     *
*     *
*     *
*     *
*******
```

  - The code to draw each box will be very similar.
    - Would variables help? Would constants help?

Wouldn't it be nice if…

```
drawBox(10, 4);
```

Continued next time…