



THE CS106A
SAGA CONTINUES

STAR WARS
Control Flow
STRIKES BACK

Control Flow Revisited

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Review

Java



Piech, CS106A, Stanford University



Making a New Variable

type

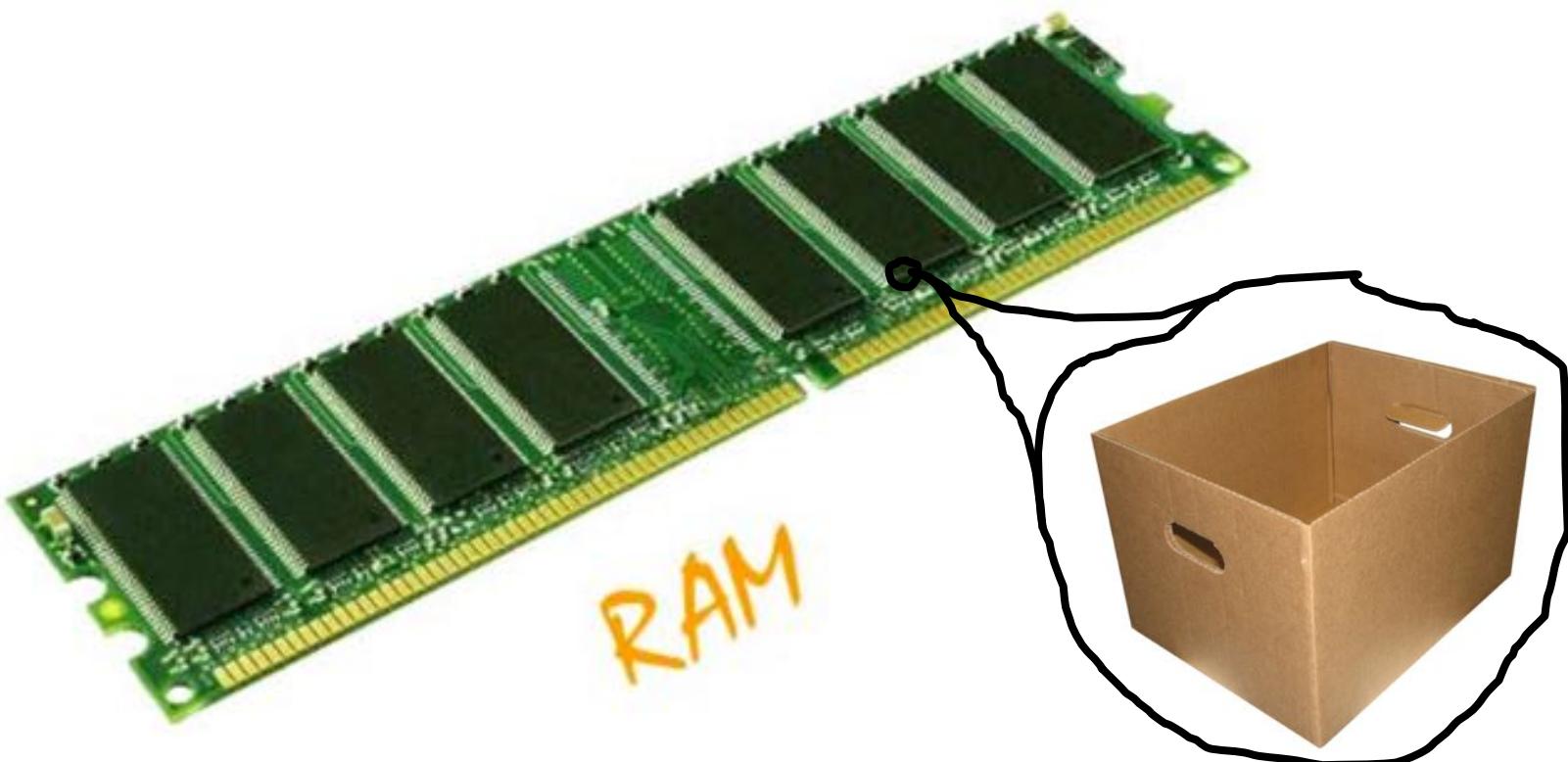
name

```
int age = 29;
```

Initial value



Teeny Tiny Boxes



My computer has space for about 2 billion boxes

Create, Modify, Use

```
// Create a variable, of type int  
// called age with the value 29.  
int age = 29;
```

```
// Modify age to be one greater.  
age = age + 1;
```

```
// Use the value in age (output it)  
println("age is: " + age);
```



Receipt Program

```
public class Receipt extends ConsoleProgram {  
    public void run() {  
        double subtotal = readDouble("Meal cost? $");  
        double tax = subtotal * 0.08;  
        double tip = subtotal * 0.20;  
        double total = subtotal + tax + tip;  
  
        println("Tax : $" + tax);  
        println("Tip: $" + tip);  
        println("Total: $" + total);  
    }  
}
```



Constants

- **constant:** A variable that cannot be changed after it is initialized. Declared at the top of your class, *outside of the run() method*. Can be used anywhere in that class.
- Better style – can easily change their values in your code, and they are easier to read in your code.
- Syntax:

private static final type name = value;

– name is usually in *ALL_UPPER_CASE*

– Examples:

```
private static final int DAYS_IN_WEEK = 7;  
private static final double TAX_PERCENT = 0.08;  
private static final int SSN = 658234569;
```



Receipt Program Before

```
public class Receipt extends ConsoleProgram {  
    public void run() {  
        double subtotal = readDouble("Meal cost? $");  
        double tax = subtotal * 0.08;  
        double tip = subtotal * 0.20;  
        double total = subtotal + tax + tip;  
  
        println("Tax : $" + tax);  
        println("Tip: $" + tip);  
        println("Total: $" + total);  
    }  
}
```



Receipt Program After

```
public class Receipt extends ConsoleProgram {  
    private static final double TAX_RATE = 0.08;  
    private static final double TIP_RATE = 0.2;  
  
    public void run() {  
        double subtotal = readDouble("Meal cost? $");  
        double tax = subtotal * TAX_RATE;  
        double tip = subtotal * TIP_RATE;  
        double total = subtotal + tax + tip;  
  
        println("Tax : $" + tax);  
        println("Tip: $" + tip);  
        println("Total: $" + total);  
    }  
}
```



Cool Example: Carbon Dating



Write a program that can turn a measurement of C14 into an estimate of age.

```
CarbonDating
Radioactive molecule = C14
Halflife = 5730 years
C14 in living organisms = 13.6 dpm
-----
What is the amount of C14 remaining in your sample: 10.2
Your sample is 2378.0 years old.
```



Example: Carbon Dating



C₁₄ = 1.2 dpm



C₁₄ = 13.6 dpm

Carbon Dating Equation

$$\text{age} = \frac{\log\left(\frac{c}{13.6}\right)}{\log\left(\frac{1}{2}\right)} \times 5730$$

Amount of C₁₄ in your sample

Fraction of C₁₄ left

Half life of C₁₄

Age of the sample

1/2 because of half life convention

- * Some of these values are constants
- ** Use the function: Math.log(num)



Binary Operators

+ Addition

- Subtraction

* Multiplication

/ Division

% Remainder

Today is your day, tio



Reminder

```
// an example of the % operator
println(17 % 4);

// reads a number from the user
int num = readInt("?: ");

// stores the ones digit
int onesDigit = num % 10;

// equal to 1 if num is odd,
// 0 if num is even.
int isOdd = num % 2;
```



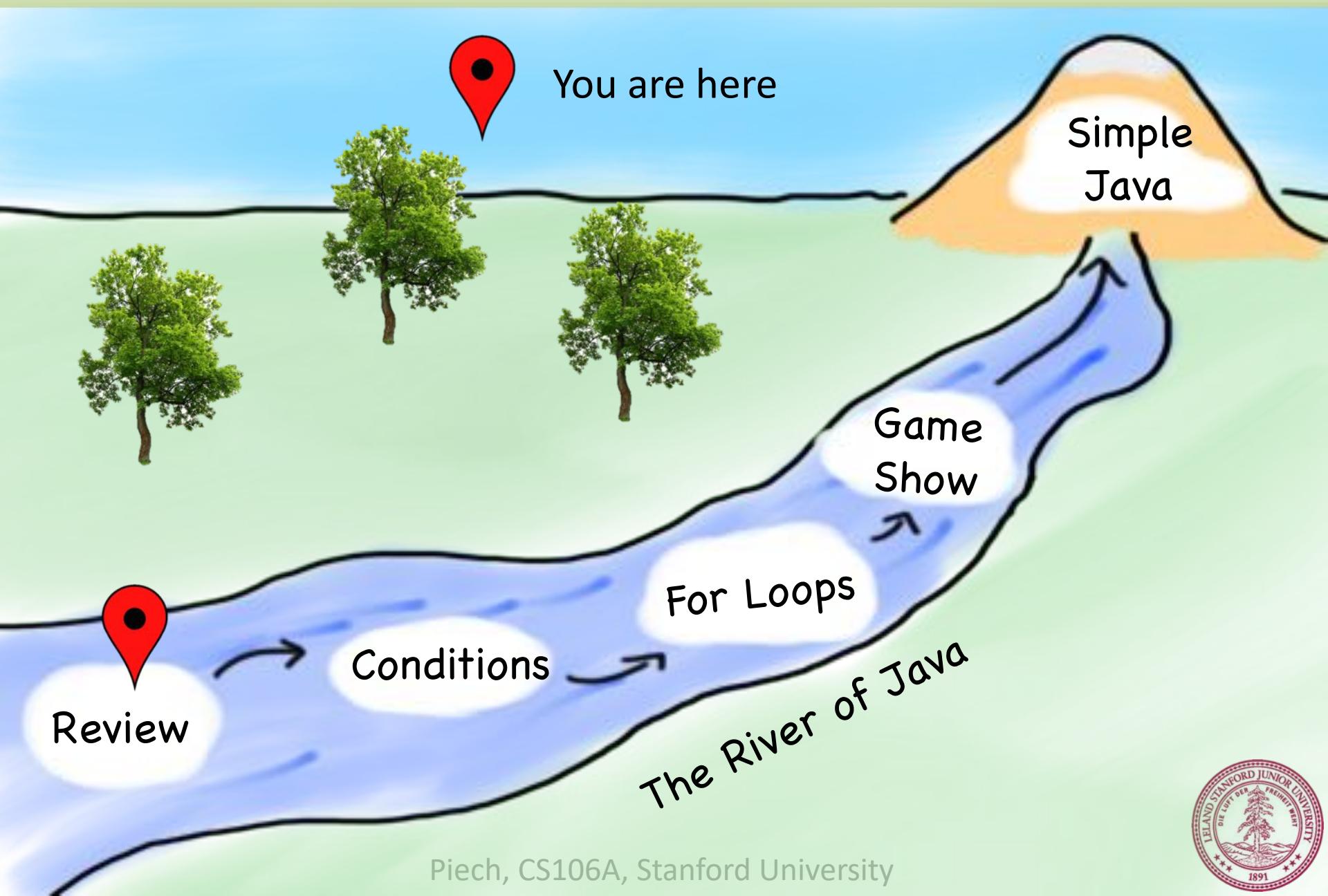
End Review

Today's Goal

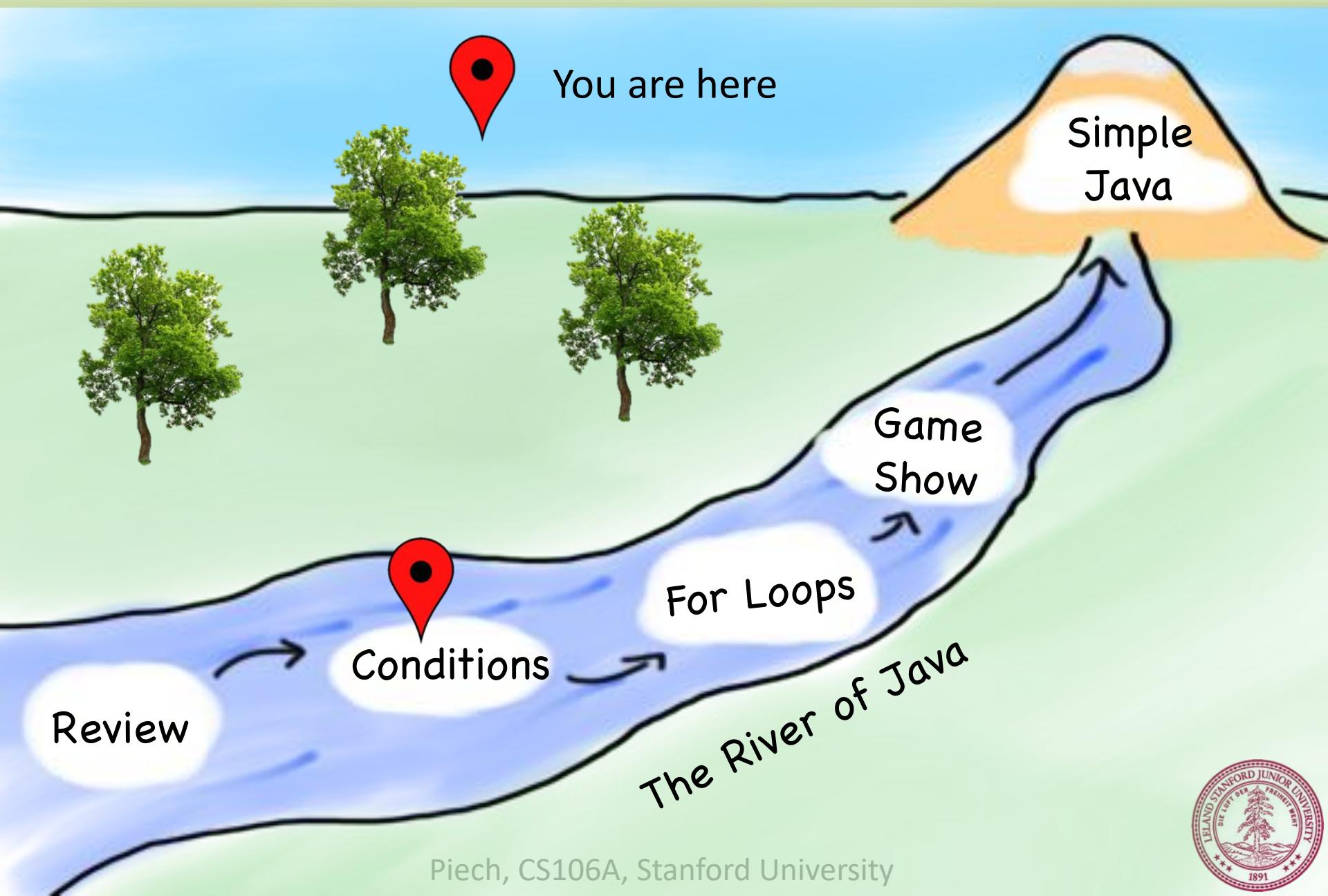
1. Be able to use For / While / If in Java



Today's Route



Today's Route



While Loop in Karel

```
while(frontIsClear()) {  
    body  
}
```

```
if(beepersPresent()) {  
    body  
}
```



While Loop Redux

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

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

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



What Does This Do?

```
// read the amount of C14 from the user
double amount = readDouble("Amount of C14 in your sample: ");

// use the half life formula to calculate the age
double fractionLeft = amountLeft / LIVING_C14;
double age = Math.log(fractionLeft) / Math.log(0.5) * HALF_LIFE;
println("Your sample is " + age + " years old.");
```

- * It calculates the age of a C14 sample



What Does This Do?

Before repeating the body,
check if this statement
evaluates to true

```
while(true) {  
    // read the amount of C14 from the user  
    double amount = readDouble("Amount of C14 in your sample: ");  
  
    // use the half life formula to calculate the age  
    double fractionLeft = amount / LIVING_C14;  
    double age = Math.log(fractionLeft) / Math.log(0.5) * HALF_LIFE;  
    println("Your sample is " + age + " years old.");  
  
    // add an extra line between queries  
    println("");  
}
```

* It repeatedly calculates the age of a C14 sample



Booleans

1 < 2



Booleans

1 < 2

true



Comparison Operators

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

* All have equal precedence



Comparison Operators

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<code>>=</code>	greater than or equal to	<code>5.0 >= 5.0</code>	<code>true</code>

* All have equal precedence



Comparison 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.");  
}
```



If Else Revisited

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



Else If

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



Example: 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



Example: 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);
```



Example: Sentinel Loops

```
// Solution #2
// harder to see loop end condition here

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



Guess My Number

```
GuessMyNumber
I am thinking of a number between 0 and 99...
Enter a guess: 50
Your guess is too high

Enter a new number: 25
Your guess is too low

Enter a new number: 40
Your guess is too low

Enter a new number: 45
Your guess is too low

Enter a new number: 48
Congrats! The number was: 48
```



Guess My Number

```
int secretNumber = getHeight() % 100;
println("I am thinking of a number between 0 and 99...");  
int guess = readInt("Enter a guess: ");
// true if guess is not equal to secret number
while(guess != secretNumber) {
    // true if guess is less than secret number
    if(guess < secretNumber) {
        println("Your guess is too low");
    } else {
        println("Your guess is too high");
    }
    println(""); // an empty line
    guess = readInt("Enter a new number: ");
}
println("Congrats! The number was: " + secretNumber);
```

92

secretNumber



Guess My Number

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50

guess

92

secretNumber



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95

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    }
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    guess = readInt("Enter a new number: ");
}
println("Congrats! The number was: " + secretNumber);
```

92

guess

92

secretNumber



Logical Operators

In order of precedence:

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

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
```



Precedence Madness

Precedence:

`! > arithmetic > comparison > logical`

`5 * 7 >= 3 + 5 * (7 - 1) && !false`



Precedence Madness

Precedence:

! > arithmetic > comparison > logical

5 * 7 >= 3 + 5 * (7 - 1) && !false

5 * 7 >= 3 + 5 * 6 && !false



Precedence Madness

Precedence:

! > arithmetic > comparison > logical

5 * 7 >= 3 + 5 * (7 - 1) && !false

5 * 7 >= 3 + 5 * 6 && !false

5 * 7 >= 3 + 5 * 6 && true



Precedence Madness

Precedence:

! > arithmetic > comparison > logical

5 * 7 >= 3 + 5 * (7 - 1) && !false

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5 * 7 >= 3 + 5 * 6 && true

35 >= 3 + 30 && true



Precedence Madness

Precedence:

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5 * 7 >= 3 + 5 * 6 && true

35 >= 3 + 30 && true

35 >= 33 && true



Precedence Madness

Precedence:

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5 * 7 >= 3 + 5 * (7 - 1) && !false

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35 >= 33 && true

true && true



Precedence Madness

Precedence:

! > arithmetic > comparison > logical

5 * 7 >= 3 + 5 * (7 - 1) && !false

5 * 7 >= 3 + 5 * 6 && !false

5 * 7 >= 3 + 5 * 6 && true

35 >= 3 + 30 && true

35 >= 33 && true

true && true

true

Never write code like this ☺



George Boole



English Mathematician 1815 – 1864
Boole died of being too cool

Piech, CS106A, Stanford University



Boolean Variables

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



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) {
    ...
}
```



Please ...

**NO FOOD OR
DRINKS**

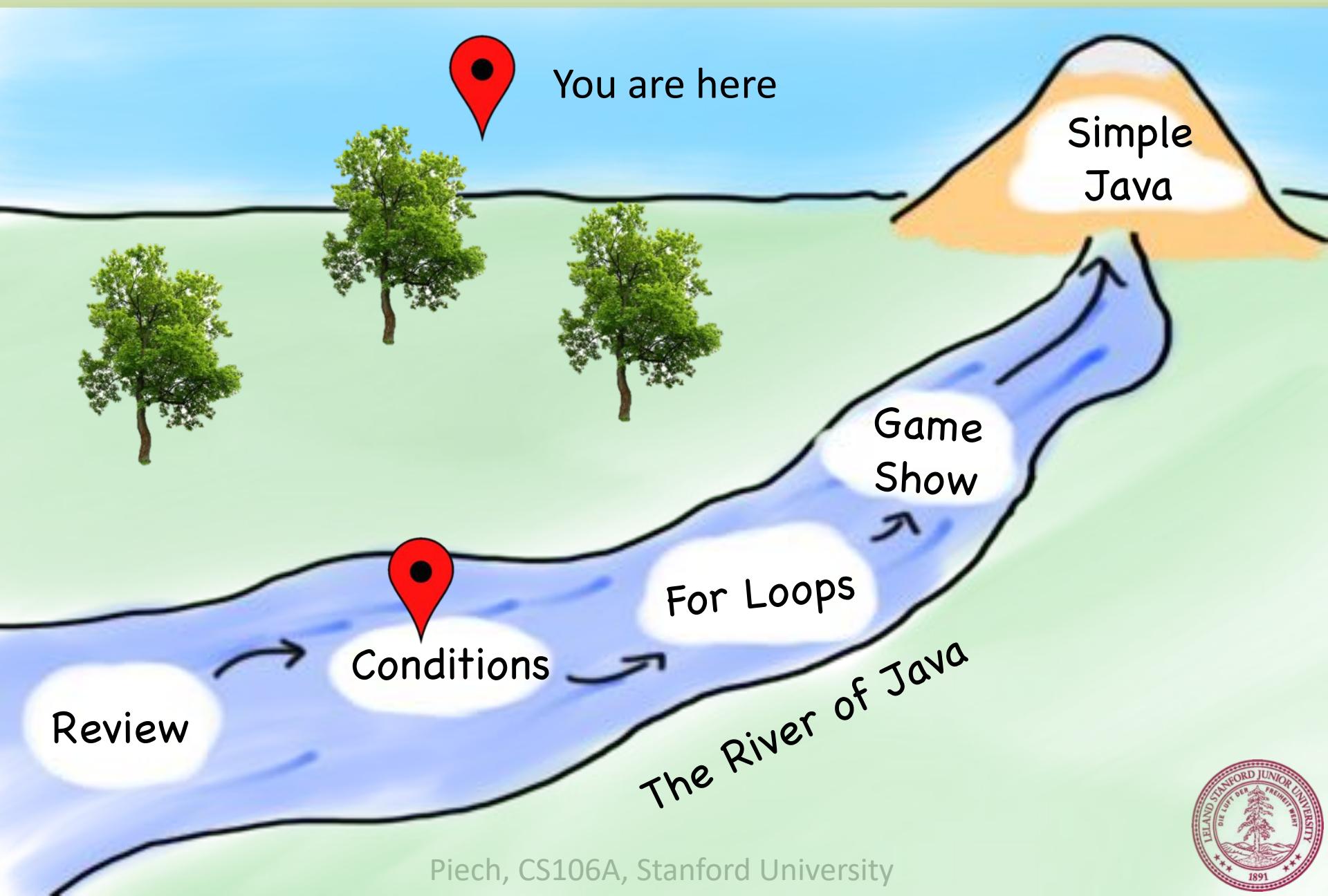
FreeSignsPrinter.com

*know your logical precedence

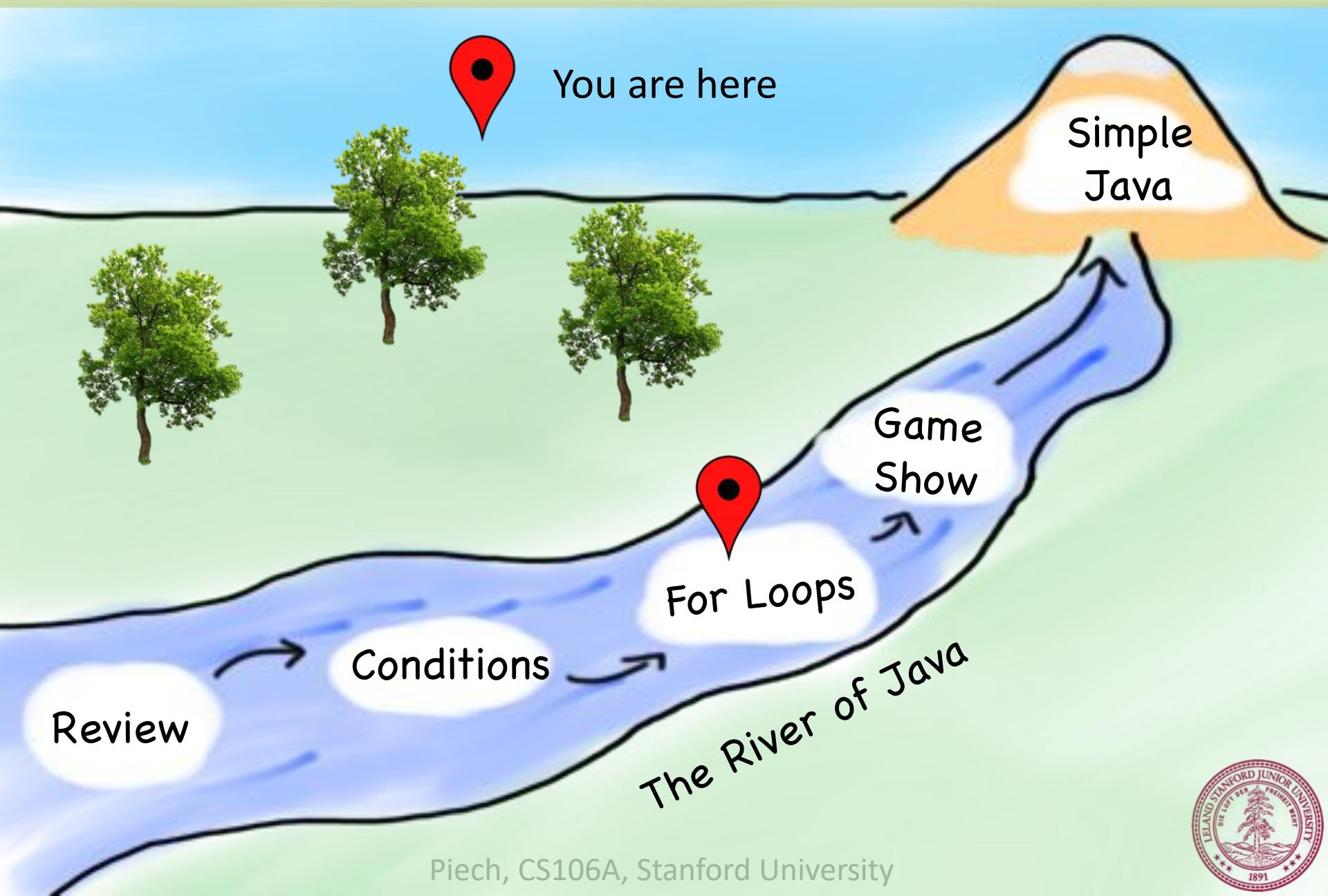
Piech, CS106A, Stanford University



Today's Route



Today's Route



How would you `println` “Stanford rocks socks”
100 times

For Loop Redux

```
public void run() {  
    for(int i = 0; i < 100; i++) {  
        println("Stanford rocks socks!");  
    }  
}
```



For Loop Redux

```
for(int i = 0; i < 100; i++) {  
    println("Stanford rocks socks!");  
}
```

This line is run once, just before the for loop starts

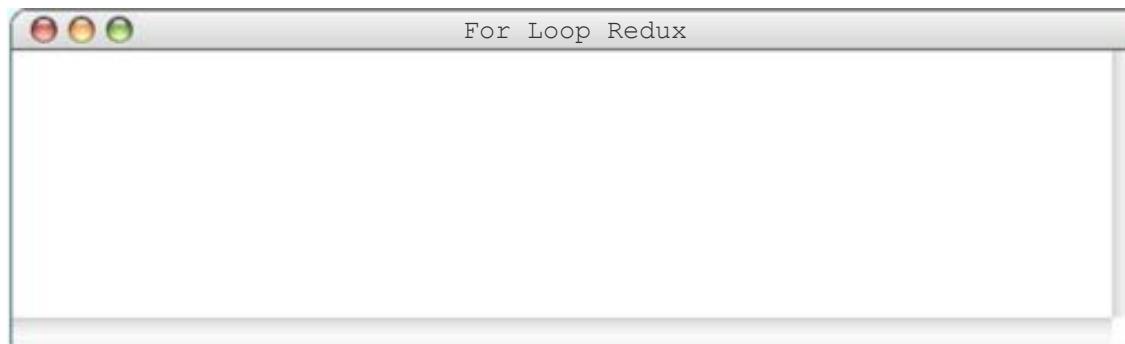
Enters the loop if this condition passes

This line is run each time the code gets to the end of the 'body'



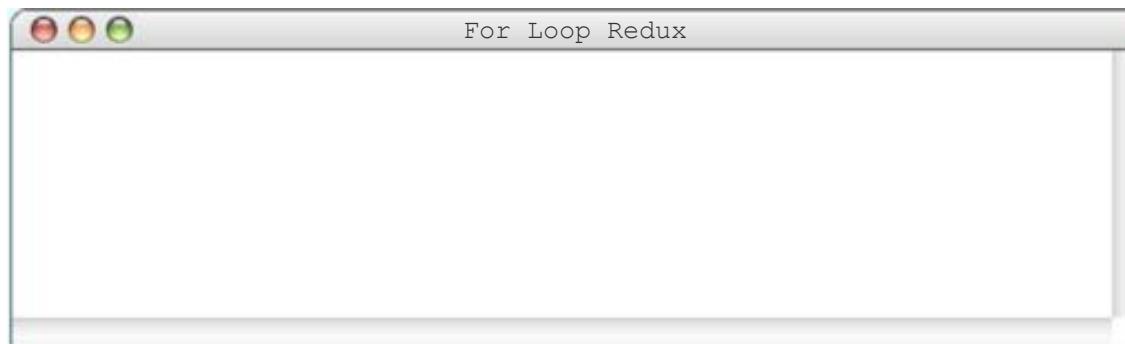
For Loop Redux

```
for(int i = 0; i < 3; i++) {  
    println("Stanford rocks socks!");  
}
```



For Loop Redux

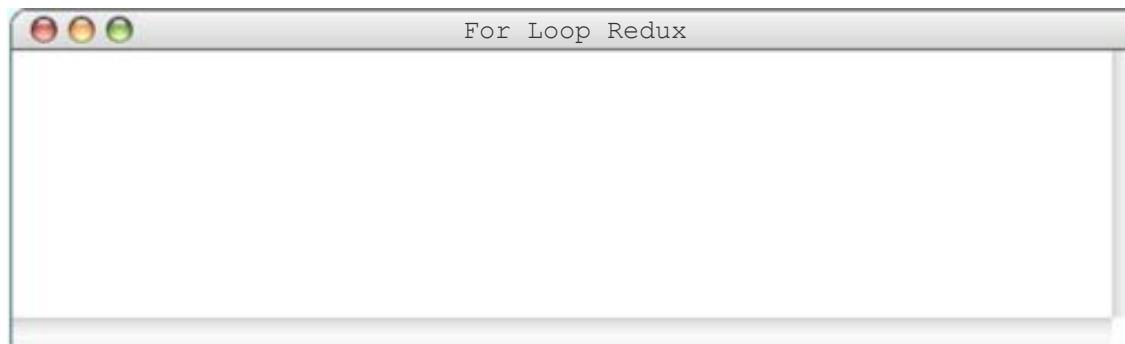
```
for(int i = 0; i < 3; i++) {  
    println("Stanford rocks socks!");  
}
```



For Loop Redux

i 0

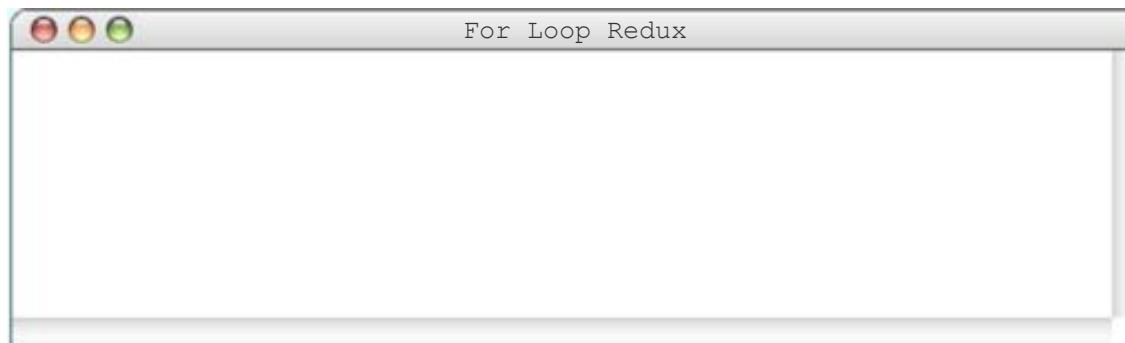
```
for(int i = 0; i < 3; i++) {  
    println("Stanford rocks socks!");  
}
```



For Loop Redux

i 0

```
for(int i = 0; i < 3; i++) {  
    println("Stanford rocks socks!");  
}
```



For Loop Redux

i 0

```
for(int i = 0; i < 3; i++) {  
    println("Stanford rocks socks!");  
}
```



For Loop Redux

i 1

```
for(int i = 0; i < 3; i++) {  
    println("Stanford rocks socks!");  
}
```



For Loop Redux

i 1

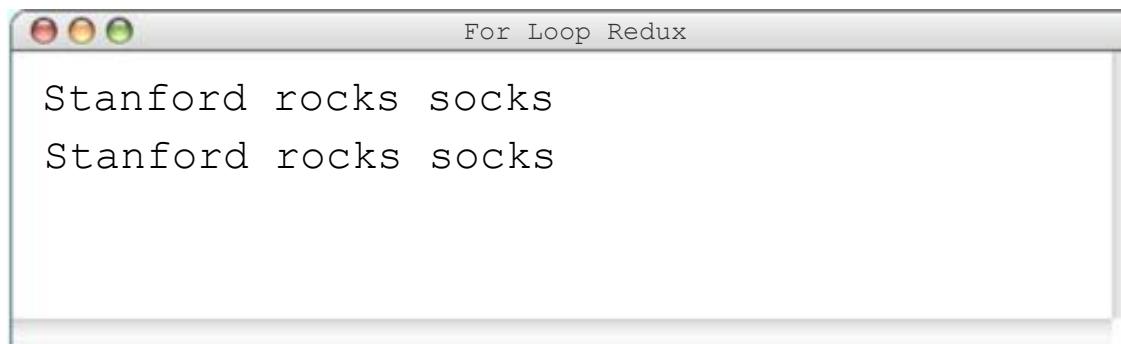
```
for(int i = 0; i < 3; i++) {  
    println("Stanford rocks socks!");  
}
```



For Loop Redux

i 1

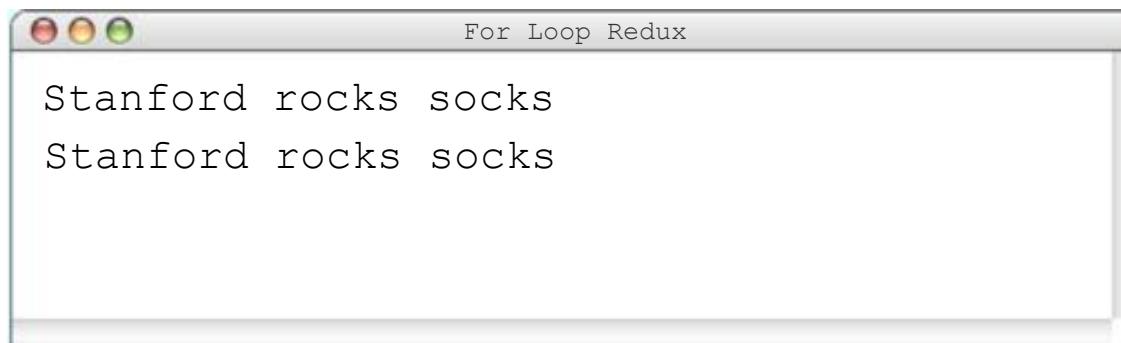
```
for(int i = 0; i < 3; i++) {  
    println("Stanford rocks socks!");  
}
```



For Loop Redux

i 2

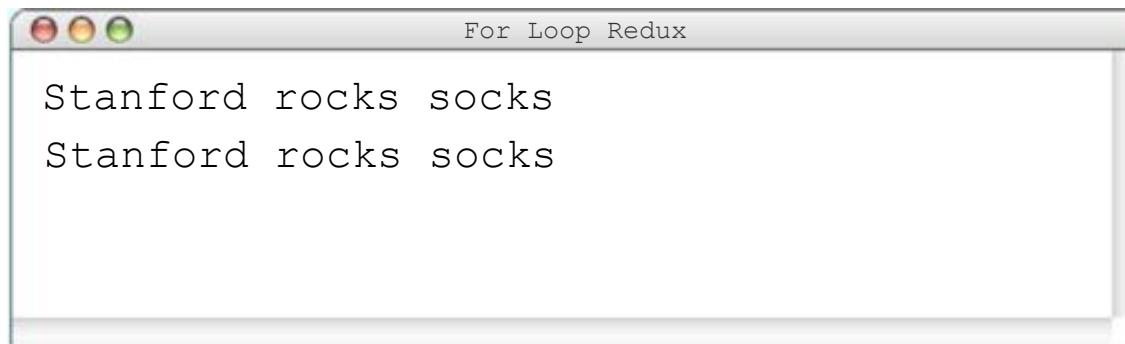
```
for(int i = 0; i < 3; i++) {  
    println("Stanford rocks socks!");  
}
```



For Loop Redux

i 2

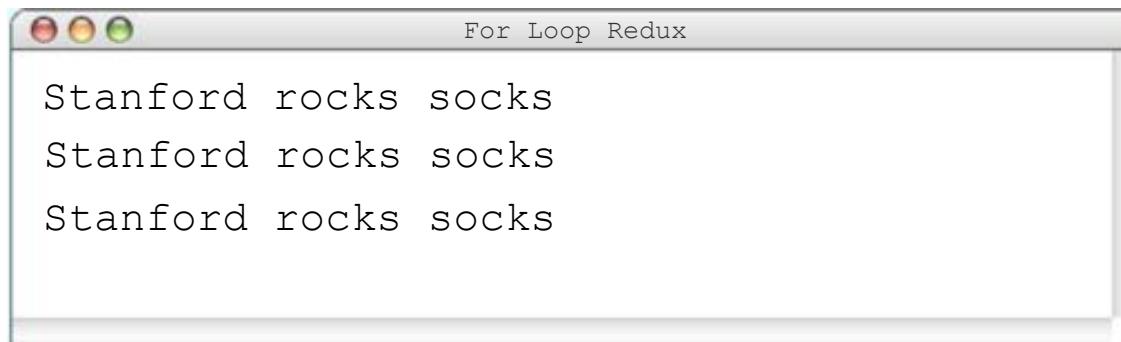
```
for(int i = 0; i < 3; i++) {  
    println("Stanford rocks socks!");  
}
```



For Loop Redux

i 2

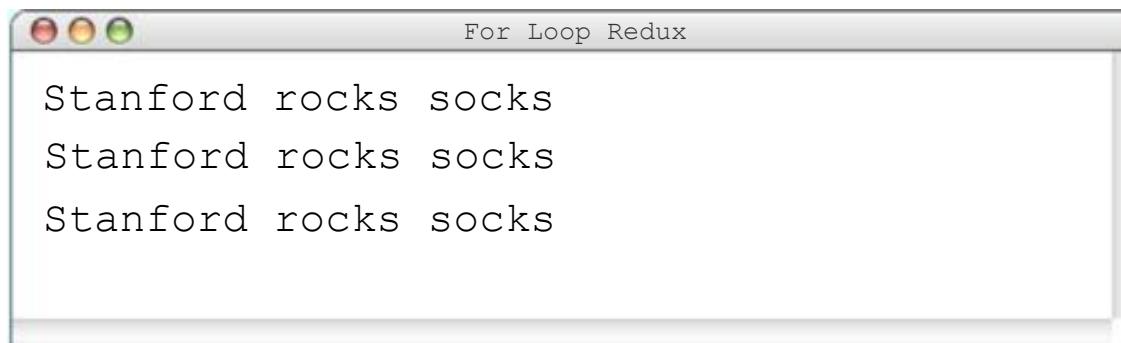
```
for(int i = 0; i < 3; i++) {  
    println("Stanford rocks socks!");  
}
```



For Loop Redux

i 3

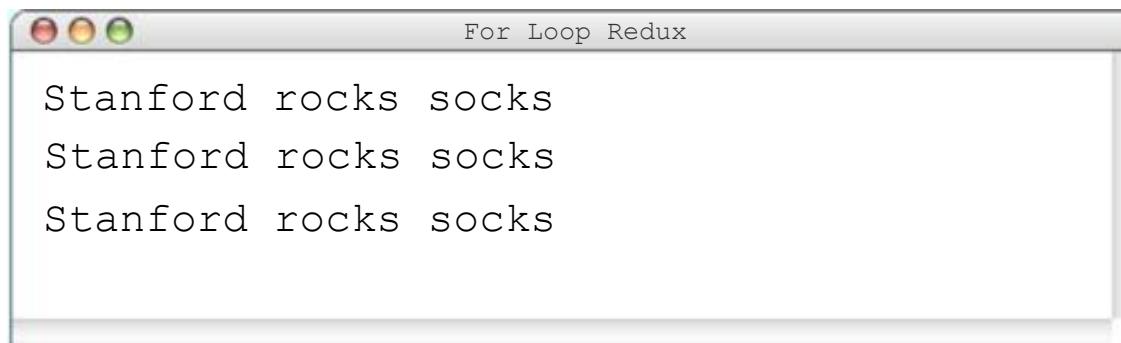
```
for(int i = 0; i < 3; i++) {  
    println("Stanford rocks socks!");  
}
```



For Loop Redux

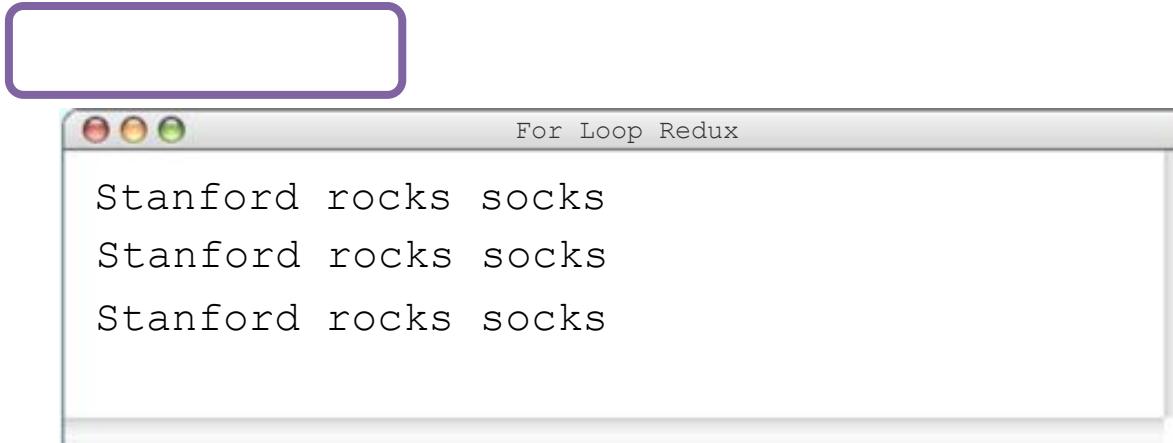
i 3

```
for(int i = 0; i < 3; i++) {  
    println("Stanford rocks socks!");  
}
```



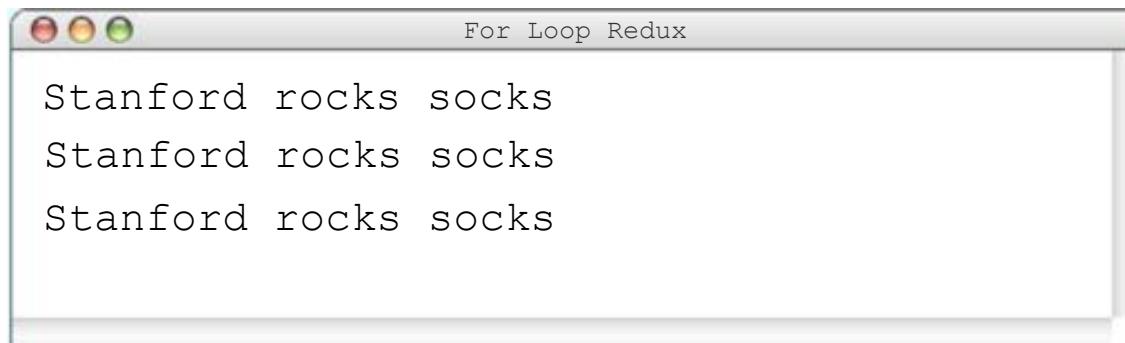
For Loop Redux

```
for(int i = 0; i < 3; i++) {  
    println("Stanford rocks socks!");  
}
```



For Loop Redux

```
for(int i = 0; i < 3; i++) {  
    println("Stanford rocks socks!");  
}
```



You can use the for loop variable



How would you `println` the first 100 even numbers?

Printing Even Numbers

```
PrintEven...  
0  
2  
4  
6  
8  
10  
12  
14  
16  
18  
20  
22  
24  
26  
28  
30  
32  
34  
36  
38
```



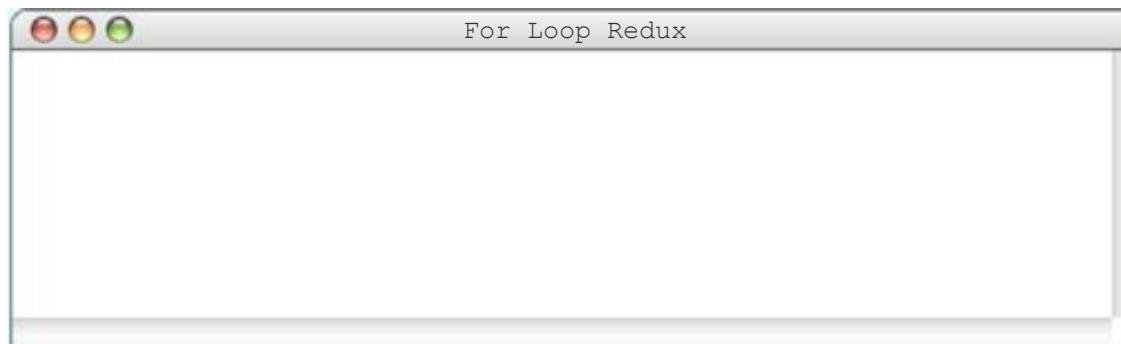
Printing Even Numbers

```
for(int i = 0; i < NUM_NUMS; i++) {  
    println(i * 2);  
}
```



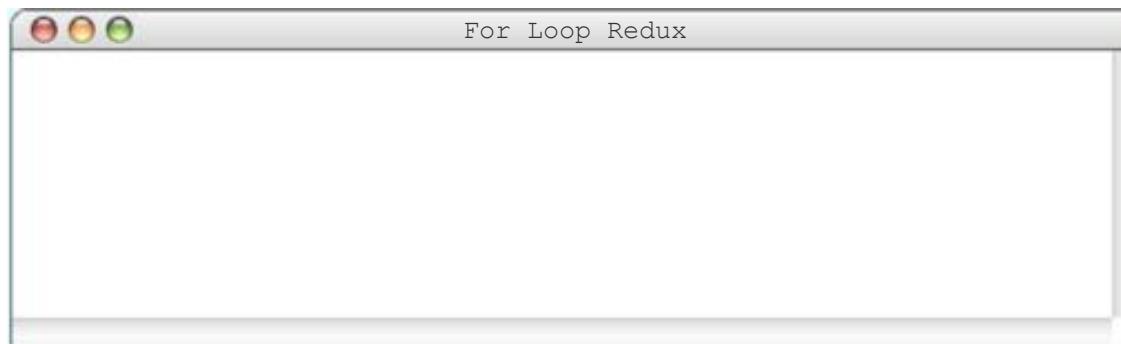
Printing Even Numbers

```
for(int i = 0; i < 3; i++) {  
    println(i * 2);  
}
```



Printing Even Numbers

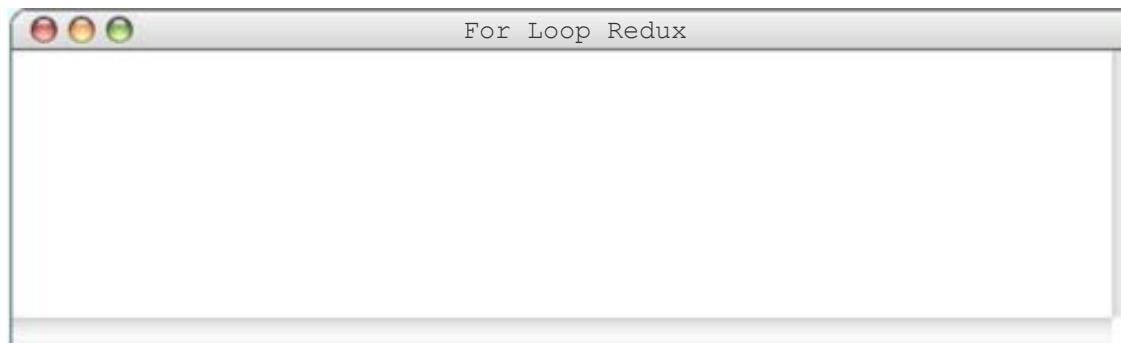
```
for(int i = 0; i < 3; i++) {  
    println(i * 2);  
}
```



Printing Even Numbers

i 0

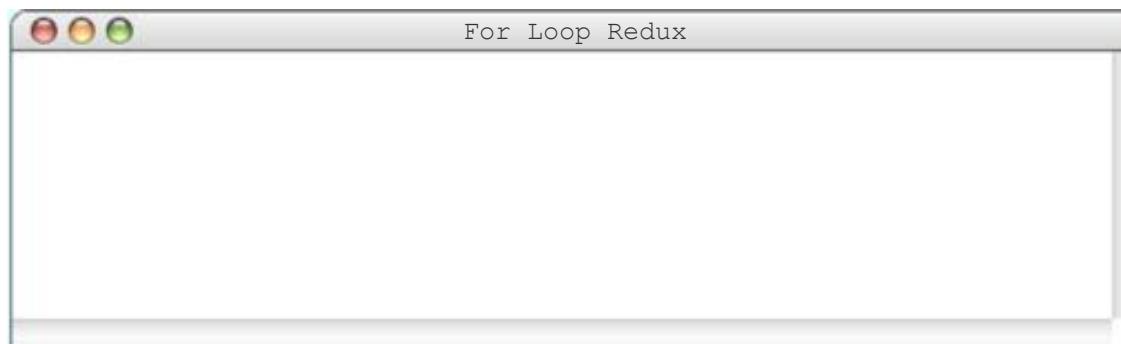
```
for(int i = 0; i < 3; i++) {  
    println(i * 2);  
}
```



Printing Even Numbers

i 0

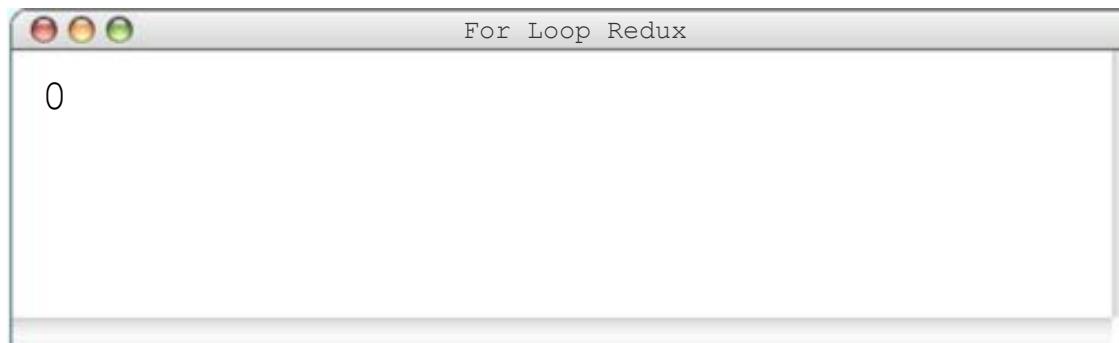
```
for(int i = 0; i < 3; i++) {  
    println(i * 2);  
}
```



Printing Even Numbers

i 0

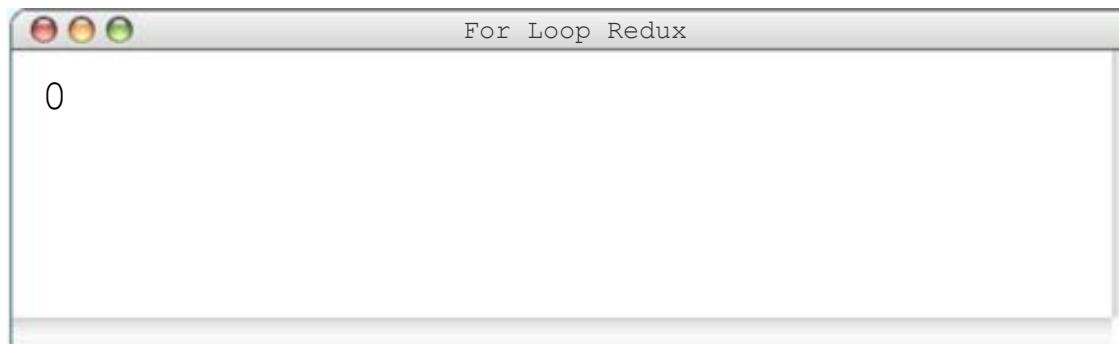
```
for(int i = 0; i < 3; i++) {  
    println(i * 2);  
}
```



Printing Even Numbers

i 1

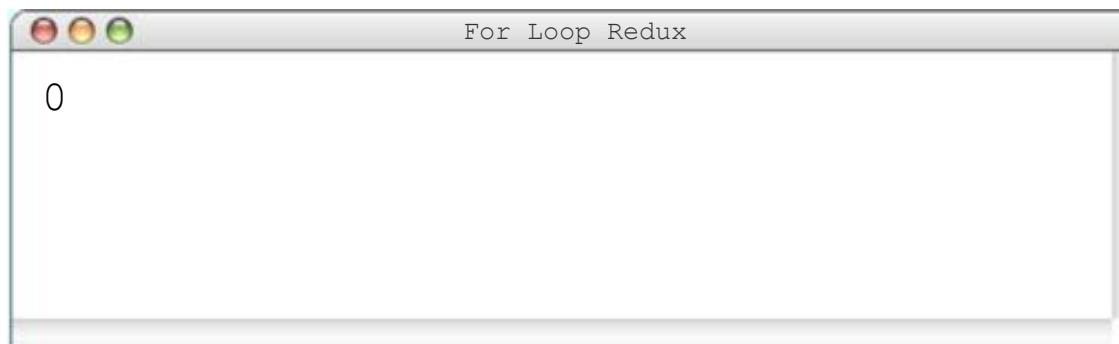
```
for(int i = 0; i < 3; i++) {  
    println(i * 2);  
}
```



Printing Even Numbers

i 1

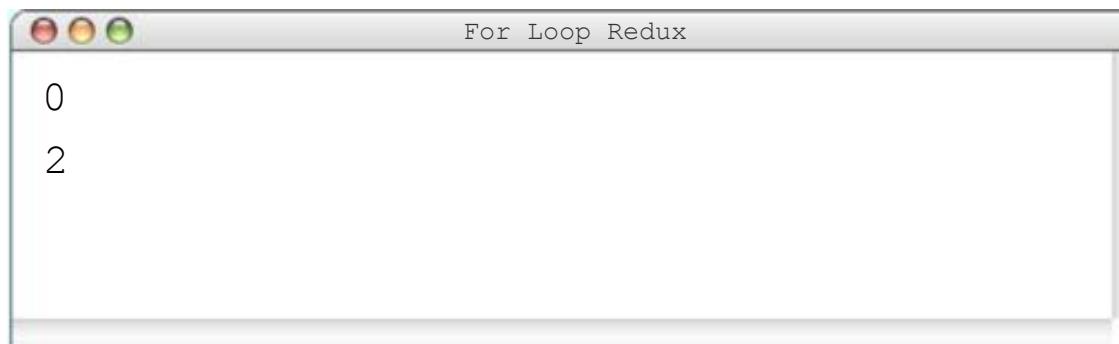
```
for(int i = 0; i < 3; i++) {  
    println(i * 2);  
}
```



Printing Even Numbers

i 1

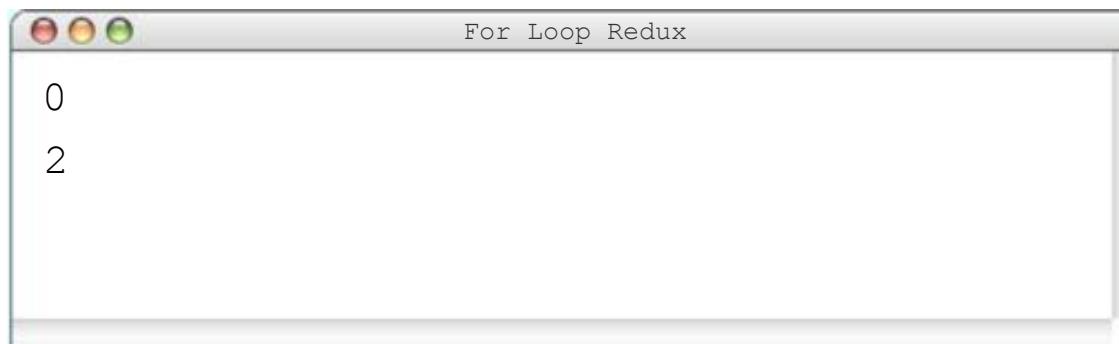
```
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    println(i * 2);  
}
```



Printing Even Numbers

i 2

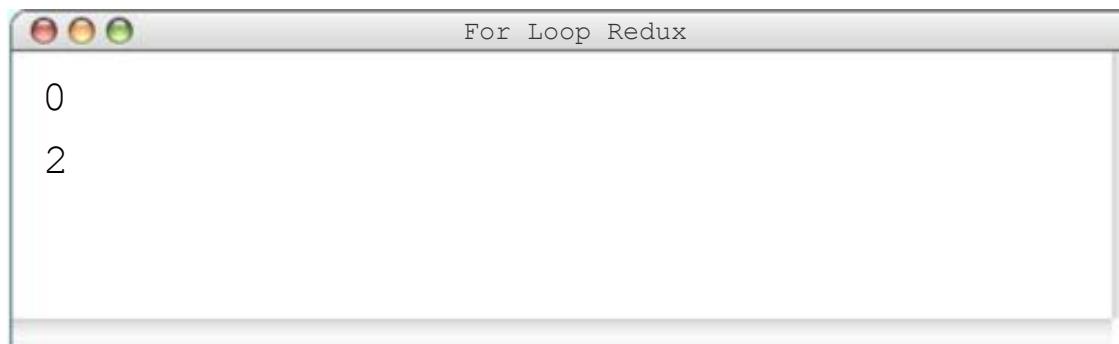
```
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    println(i * 2);  
}
```



Printing Even Numbers

i 2

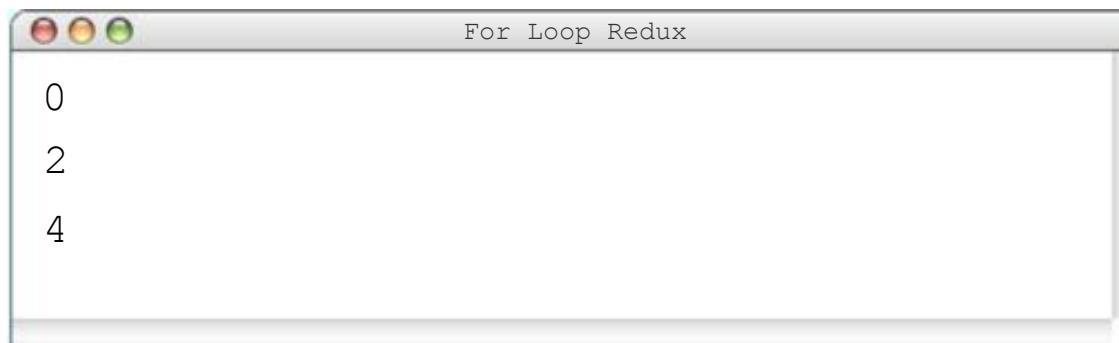
```
for(int i = 0; i < 3; i++) {  
    println(i * 2);  
}
```



Printing Even Numbers

i 2

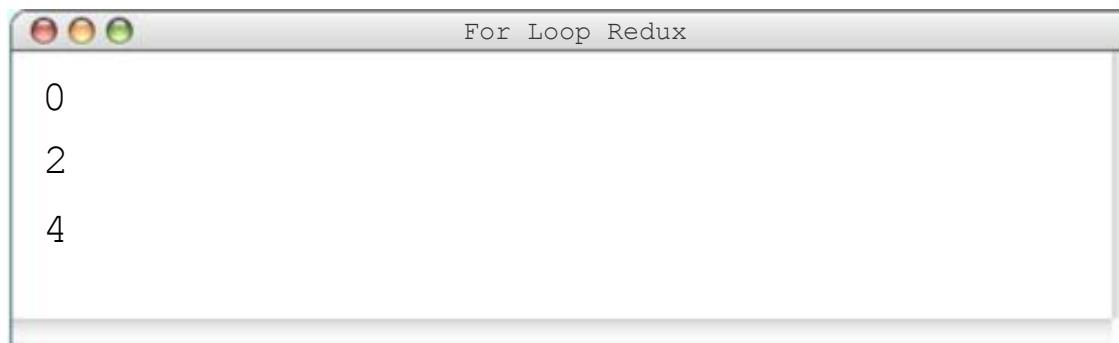
```
for(int i = 0; i < 3; i++) {  
    println(i * 2);  
}
```



Printing Even Numbers

i 3

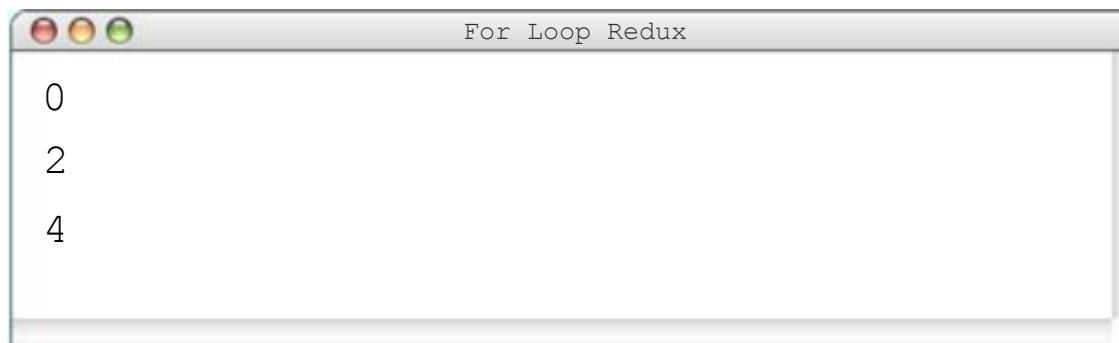
```
for(int i = 0; i < 3; i++) {  
    println(i * 2);  
}
```



Printing Even Numbers

i 3

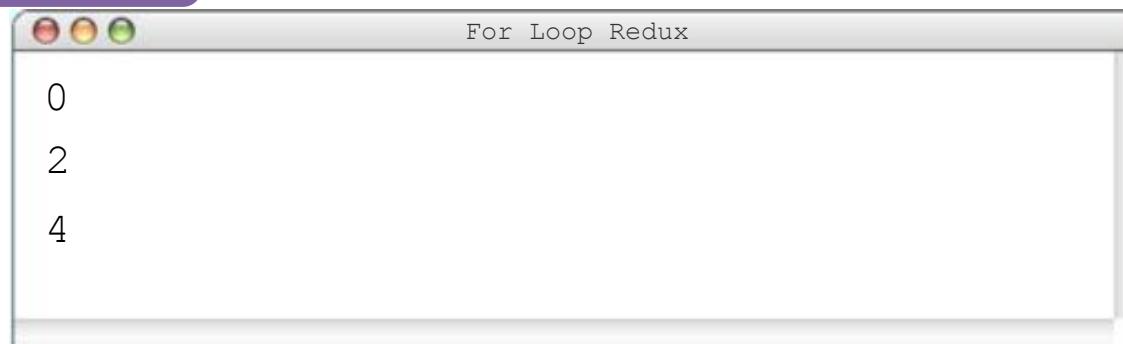
```
for(int i = 0; i < 3; i++) {  
    println(i * 2);  
}
```



Printing Even Numbers

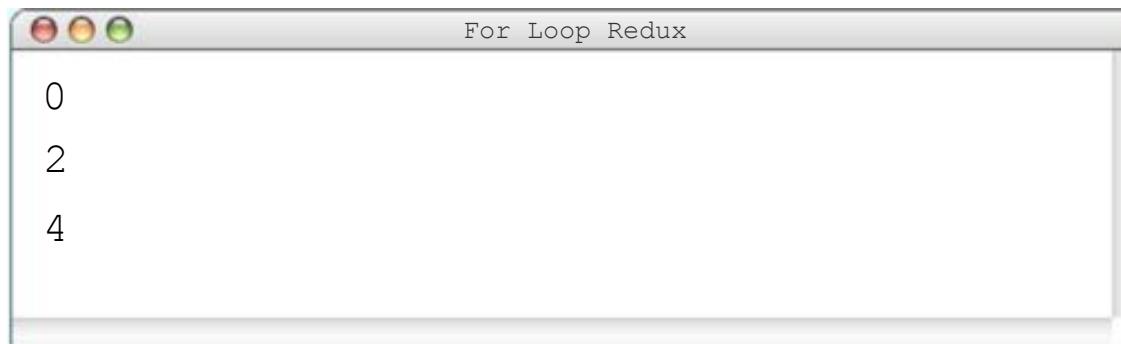
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    println(i * 2);  
}
```

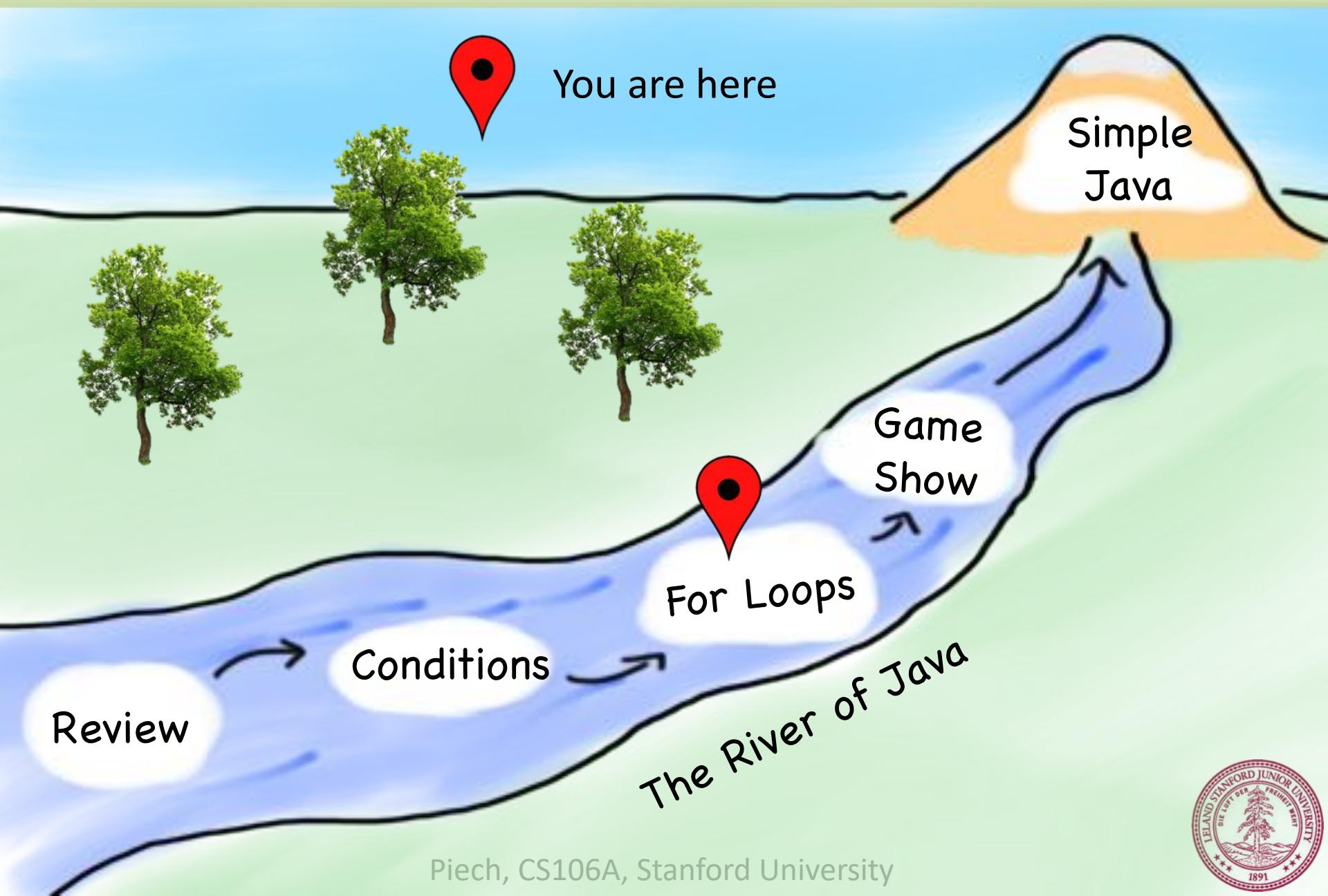


Printing Even Numbers

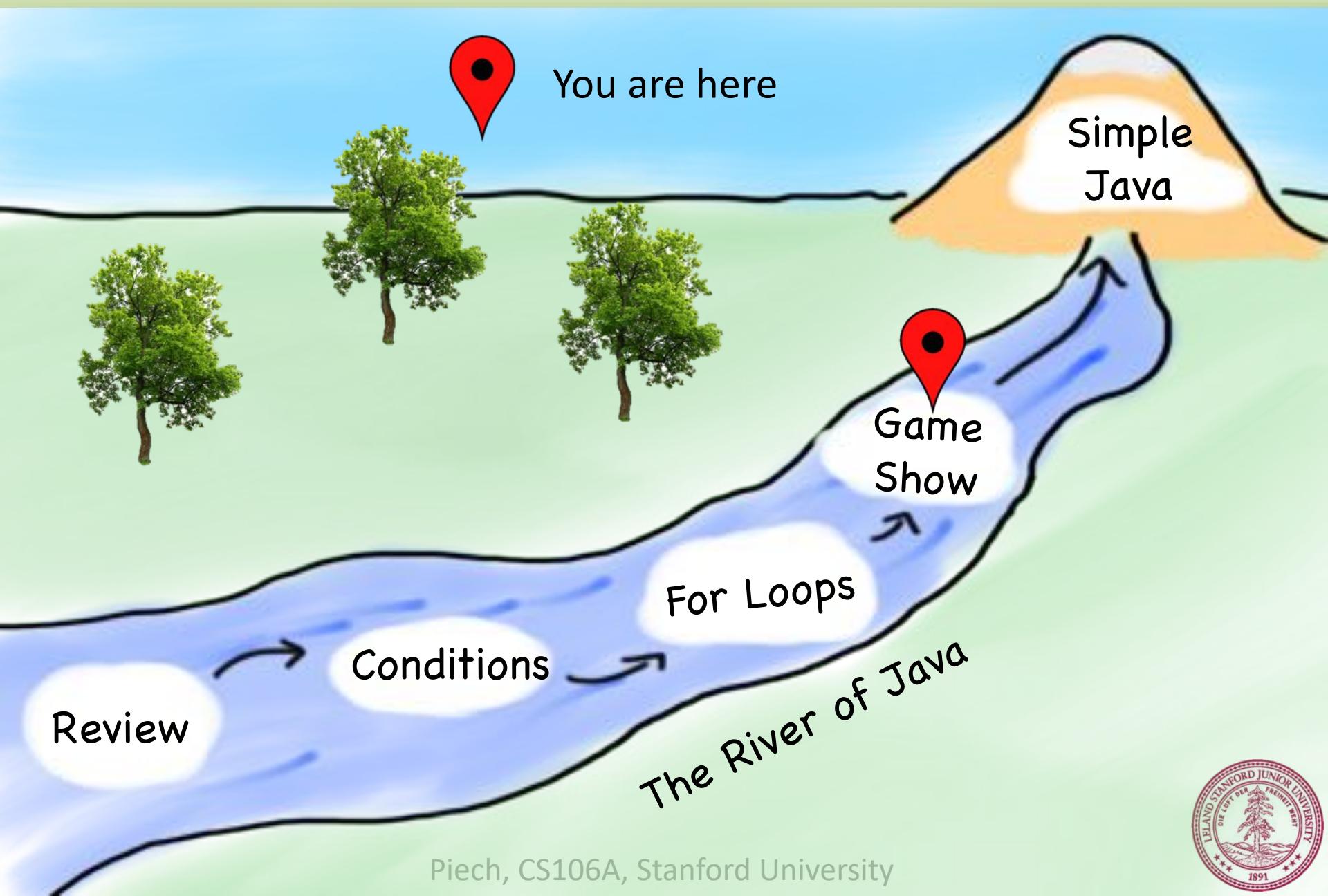
```
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    println(i * 2);  
}
```



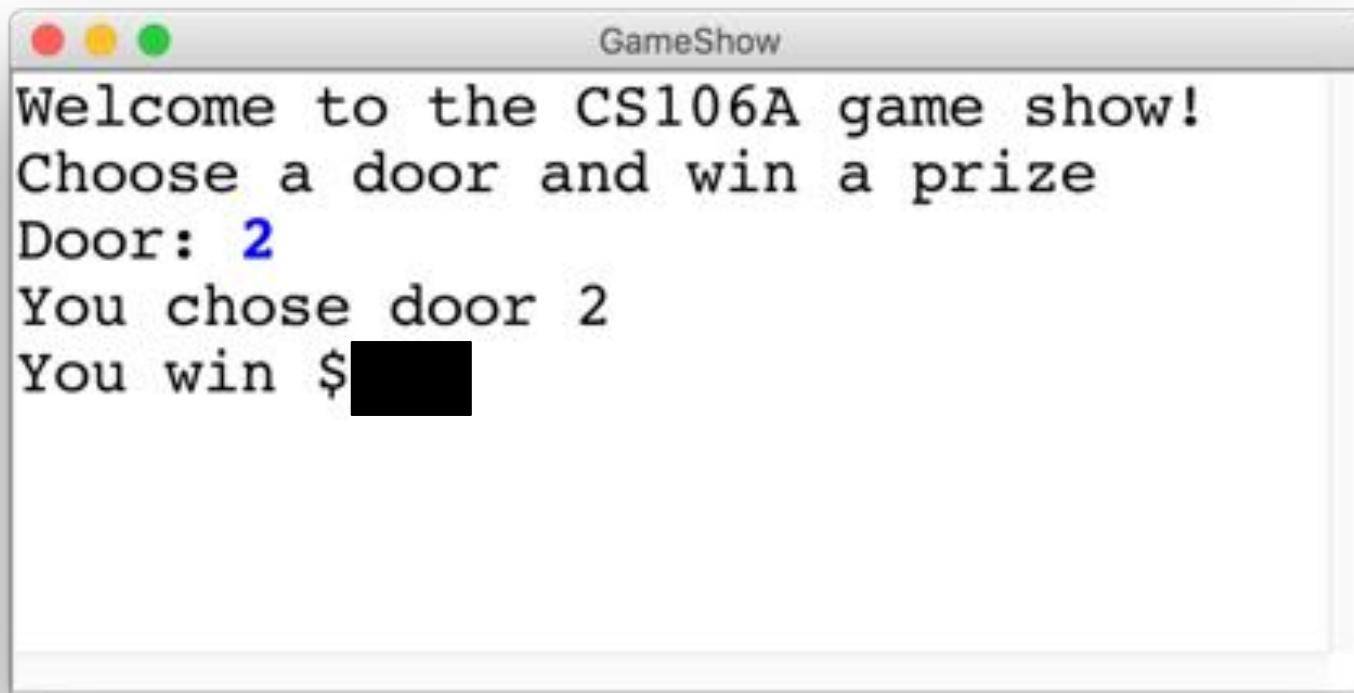
Today's Route



Today's Route



Game Show



Choose a Door

```
int door = readInt("Door: ");
// while the input is invalid
while(door < 1 || door > 3) {
    // tell the user the input was invalid
    println("Invalid door!");
    // ask for a new input
    door = readInt("Door: ");
}
```

|| or
&& and



The Door Logic

```
int prize = 4;  
if(door == 1) {  
    prize = 2 + 9 / 10 * 100;  
} else if(door == 2) {  
    boolean locked = prize % 2 != 0;  
    if(!locked) {  
        prize += 6;  
    }  
} else if(door == 3) {  
    prize++;  
}
```



The Door Logic

```
int prize = 4;  
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    boolean locked = prize % 2 != 0;  
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        prize += 6;  
    }  
} else if(door == 3) {  
    prize++;  
}
```



The Door Logic

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        prize += 6;  
    }  
} else if(door == 3) {  
    prize++;  
}
```



The Door Logic

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} else if(door == 3) {  
    prize++;  
}  
}
```



The Door Logic

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    if(!locked) {  
        prize += 6;  
    }  
} else if(door == 3) {  
    prize++;  
}
```



Today's Goal

1. Be able to use For / While / If in Java

