Java

Conditionals, While loop, For Loop

Conditionals

Java - Conditionals

```java
package week1;

public class PlusMinus {
    public static String letter(int score){
        int tens=score/10;
        if (tens>=9){
            return "A";
        } else if(tens>=8){
            return "B";
        } else if(tens>=7){
            String result = "C";
            return result;
        } else if(tens>=6){
            return "D";
        } else {
            return "F";
        }
    }

    public static void main(String[] args) {
        String result = letter(98);
        System.out.println(result);
        result = letter(75);
        System.out.println(result);
        result = letter(30);
        System.out.println(result);
    }
}
```

- Conditionals (if/else if/else)
- Parentheses around each boolean expression for if and else if
- Braces {} around each code block

Memory Diagram

```java
package week1;

public class PlusMinus {
    public static String letter(int score){
        int tens=score/10;
        if (tens>=9){
            return "A";
        } else if(tens>=8){
            return "B";
        } else if(tens>=7){
            String result = "C";
            return result;
        } else if(tens>=6){
            return "D";
        } else {
            return "F";
        }
    }

    public static void main(String[] args) {
        String result = letter(98);
        System.out.println(result);
        result = letter(75);
        System.out.println(result);
        result = letter(30);
        System.out.println(result);
    }
}
```

Stack		Heap
Name	Value	

in/out

- Setup the memory diagram
- Start the program at the main method

```java
package week1;

public class PlusMinus {
    public static String letter(int score){
        int tens=score/10;
        if (tens>=9){
            return "A";
        } else if(tens>=8){
            return "B";
        } else if(tens>=7){
            String result = "C";
            return result;
        } else if(tens>=6){
            return "D";
        } else {
            return "F";
        }
    }

    public static void main(String[] args) {
        String result = letter(98);
        System.out.println(result);
        result = letter(75);
        System.out.println(result);
        result = letter(30);
        System.out.println(result);
    }
}
```

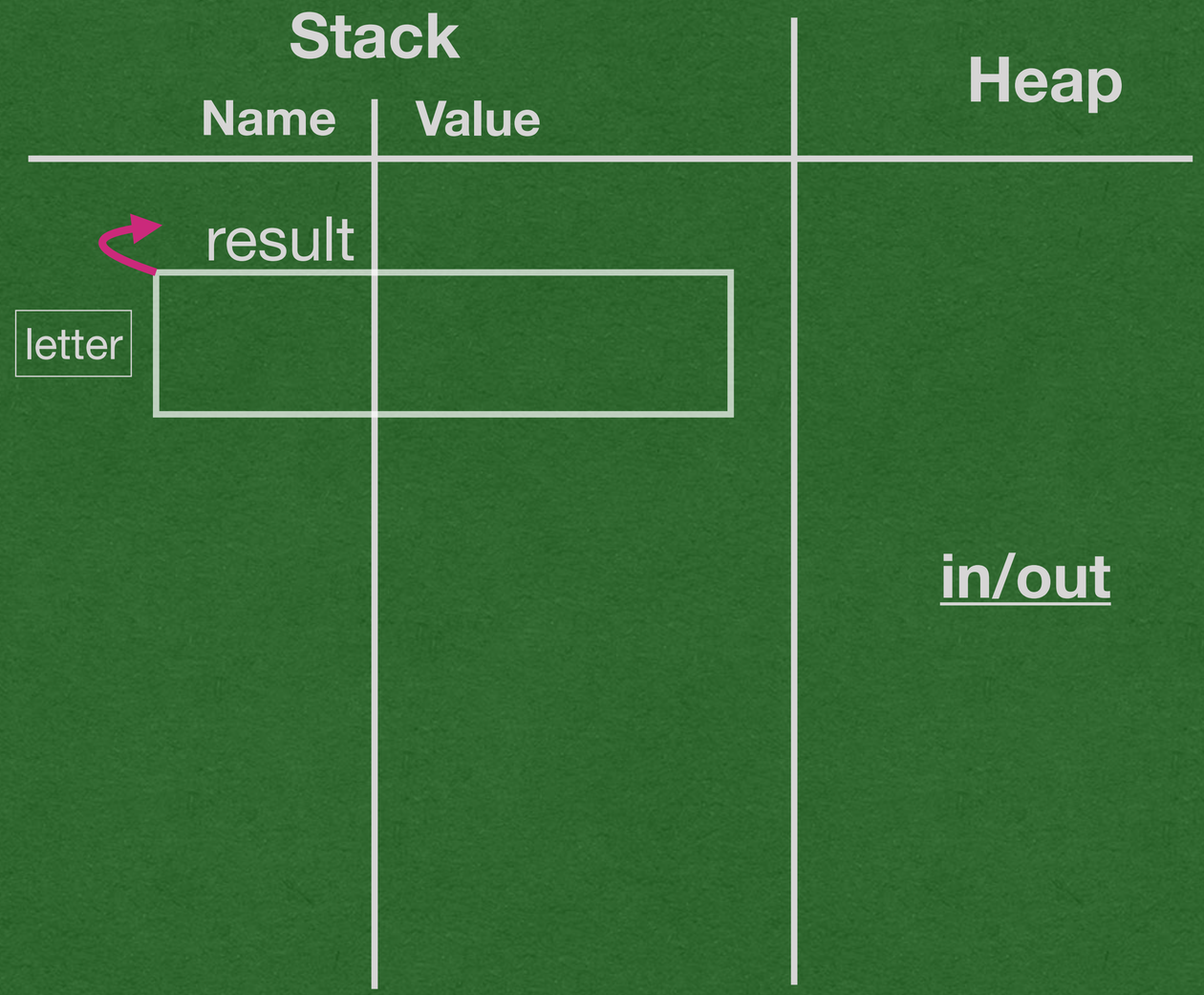
Stack		Heap
Name	Value	
result		
		in/out

- We start with a method call
- Add "result" to the stack with name only

```java
package week1;

public class PlusMinus {
    public static String letter(int score){
        int tens=score/10;
        if (tens>=9){
            return "A";
        } else if(tens>=8){
            return "B";
        } else if(tens>=7){
            String result = "C";
            return result;
        } else if(tens>=6){
            return "D";
        } else {
            return "F";
        }
    }

    public static void main(String[] args) {
        String result = letter(98);
        System.out.println(result);
        result = letter(75);
        System.out.println(result);
        result = letter(30);
        System.out.println(result);
    }
}
```

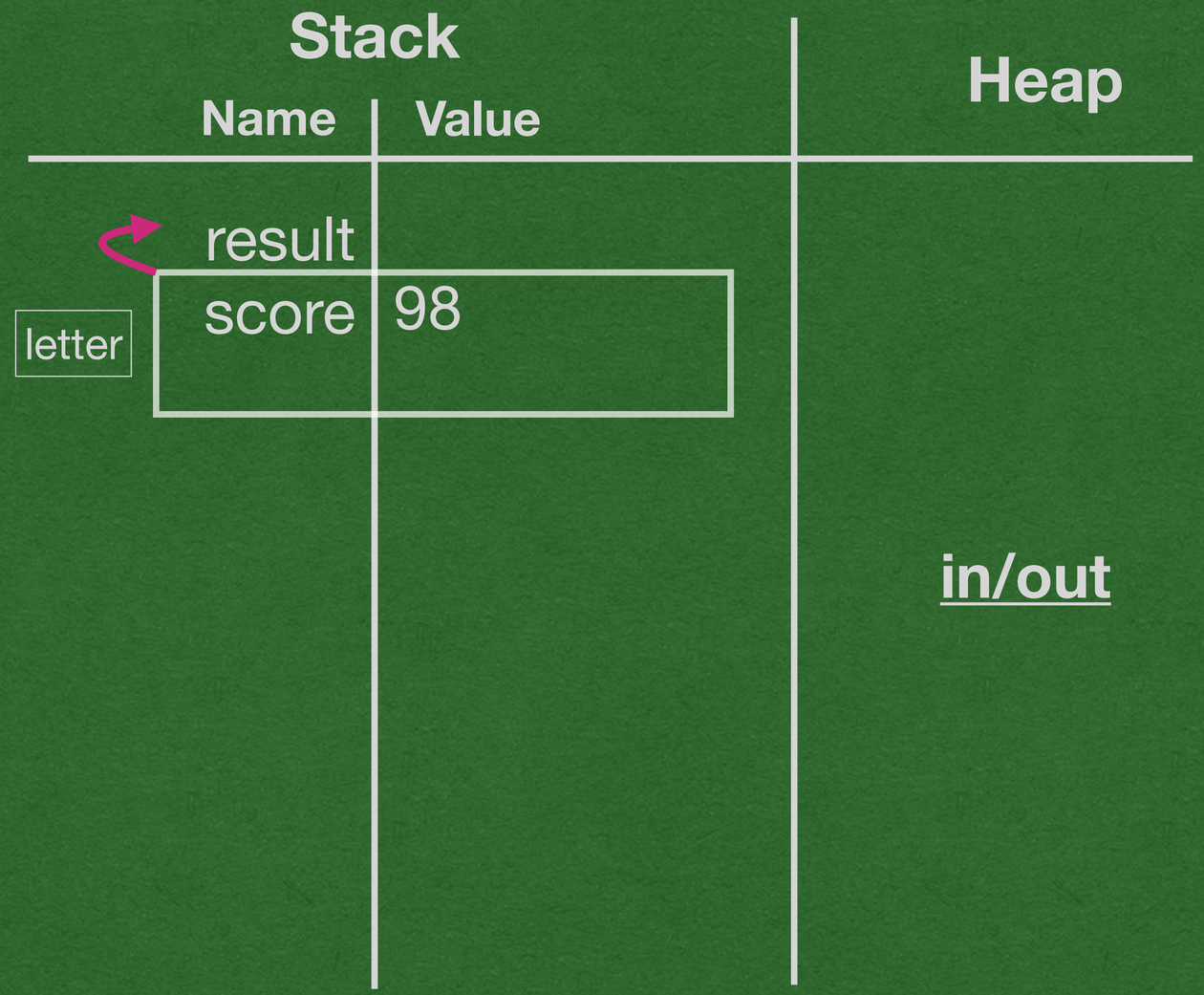


- Add a stack frame for the method call
- Write the name of the method being called
- Draw a return arrow showing where the return value will go

```java
package week1;

public class PlusMinus {
    public static String letter(int score){
        int tens=score/10;
        if (tens>=9){
            return "A";
        } else if(tens>=8){
            return "B";
        } else if(tens>=7){
            String result = "C";
            return result;
        } else if(tens>=6){
            return "D";
        } else {
            return "F";
        }
    }

    public static void main(String[] args) {
        String result = letter(98);
        System.out.println(result);
        result = letter(75);
        System.out.println(result);
        result = letter(30);
        System.out.println(result);
    }
}
```

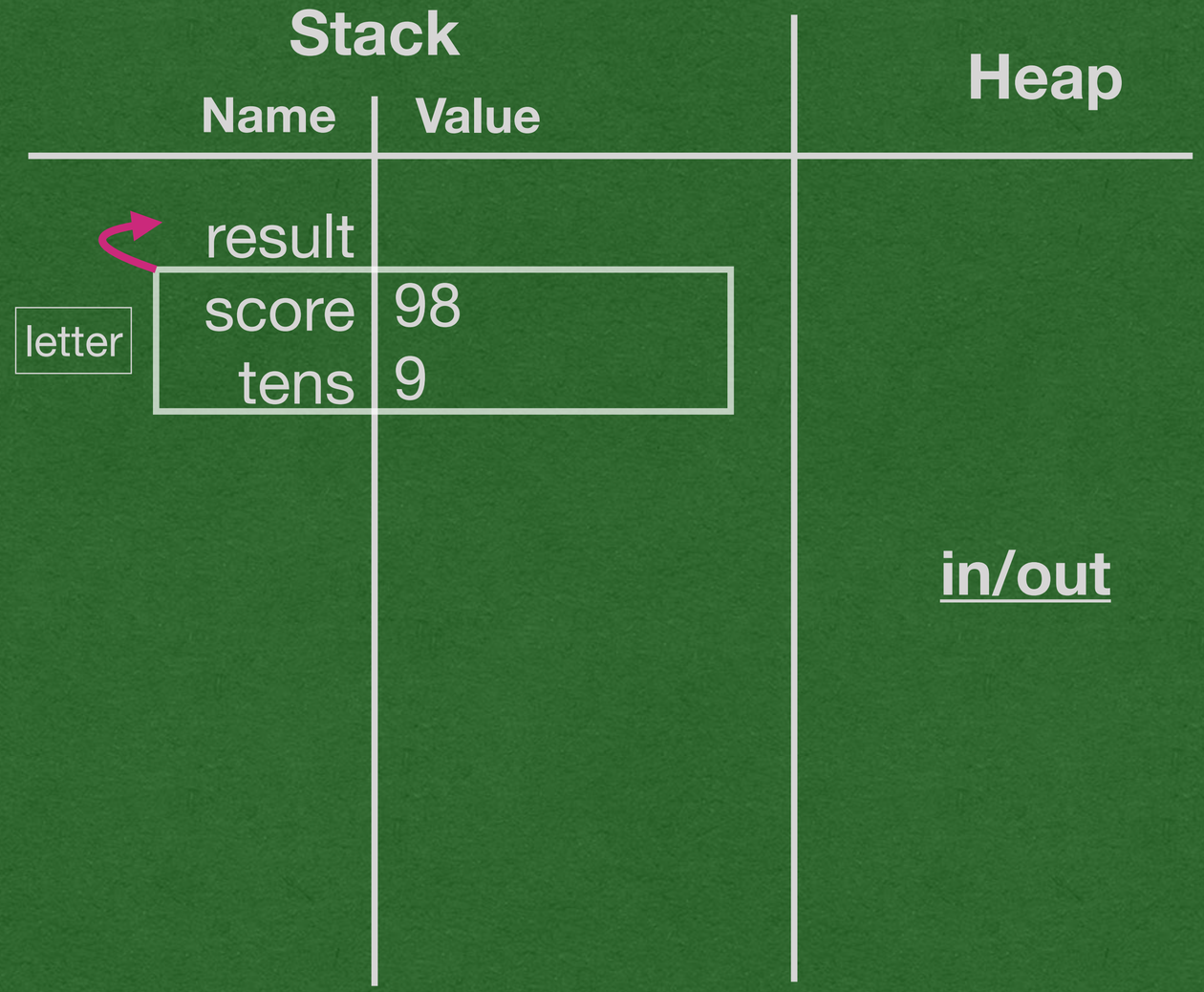


- Start the method call by adding the parameter(s) to the stack inside the new stack frame
- Assign the parameter(s) the value(s) of the argument(s)

```java
package week1;

public class PlusMinus {
    public static String letter(int score){
        int tens=score/10;
        if (tens>=9){
            return "A";
        } else if(tens>=8){
            return "B";
        } else if(tens>=7){
            String result = "C";
            return result;
        } else if(tens>=6){
            return "D";
        } else {
            return "F";
        }
    }

    public static void main(String[] args) {
        String result = letter(98);
        System.out.println(result);
        result = letter(75);
        System.out.println(result);
        result = letter(30);
        System.out.println(result);
    }
}
```



- Variables declared as part of the method call are added inside that method's stack frame

```java
package week1;

public class PlusMinus {
    public static String letter(int score){
        int tens=score/10;
        if (tens>=9){
            return "A";
        } else if(tens>=8){
            return "B";
        } else if(tens>=7){
            String result = "C";
            return result;
        } else if(tens>=6){
            return "D";
        } else {
            return "F";
        }
    }

    public static void main(String[] args) {
        String result = letter(98);
        System.out.println(result);
        result = letter(75);
        System.out.println(result);
        result = letter(30);
        System.out.println(result);
    }
}
```

Stack

Name	Value
result	
score	98
tens	9

letter

Heap

in/out

- The boolean expression "tens>=9" evaluates to true
- Enter the code block

```java
package week1;

public class PlusMinus {
    public static String letter(int score){
        int tens=score/10;
        if (tens>=9){
            return "A";
        } else if(tens>=8){
            return "B";
        } else if(tens>=7){
            String result = "C";
            return result;
        } else if(tens>=6){
            return "D";
        } else {
            return "F";
        }
    }

    public static void main(String[] args) {
        String result = letter(98);
        System.out.println(result);
        result = letter(75);
        System.out.println(result);
        result = letter(30);
        System.out.println(result);
    }
}
```

Stack

Name	Value
result	
score	98
tens	9

letter

Heap

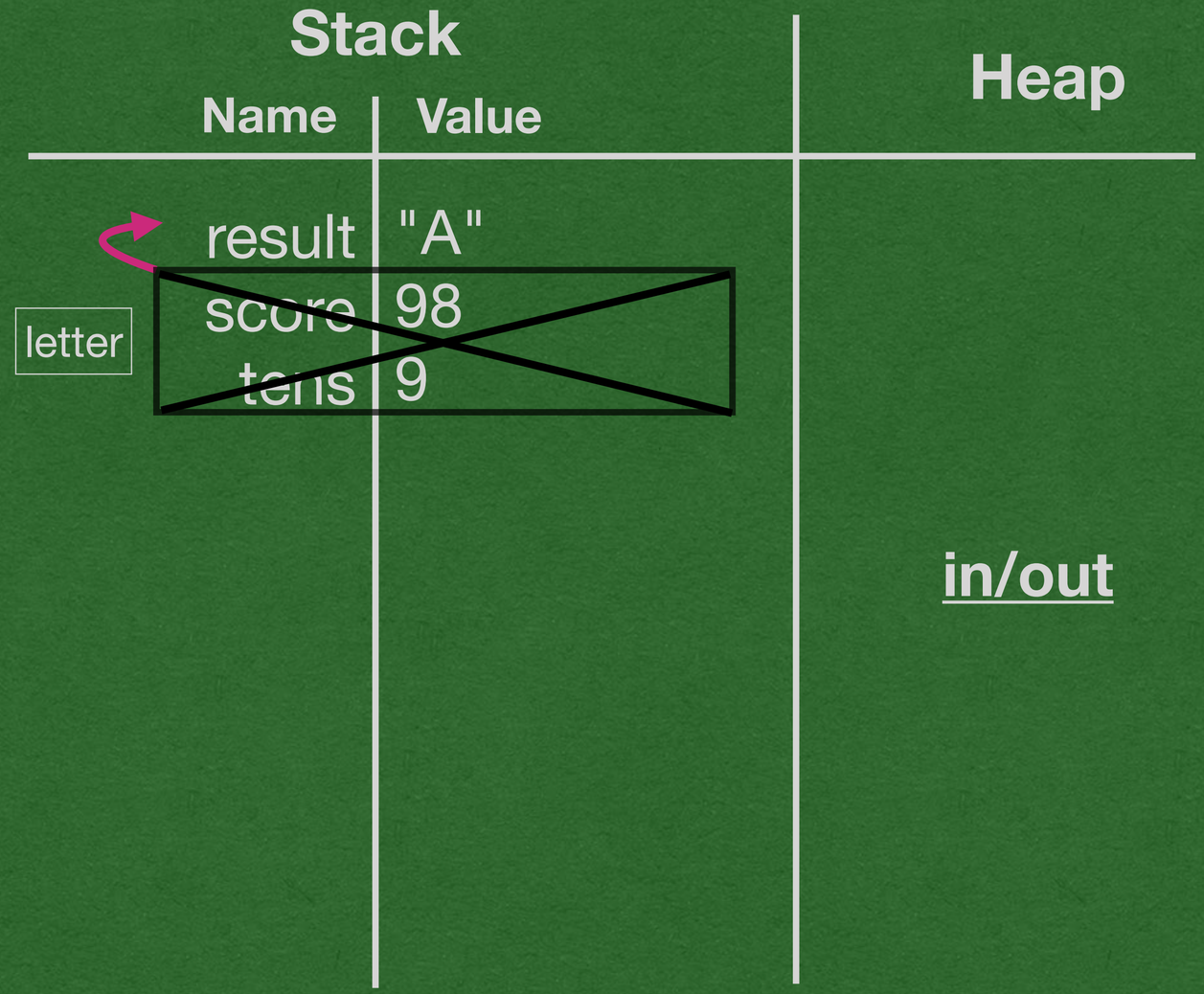
in/out

- We reach a return statement
- Method ends and returns "A"

```java
package week1;

public class PlusMinus {
    public static String letter(int score){
        int tens=score/10;
        if (tens>=9){
            return "A";
        } else if(tens>=8){
            return "B";
        } else if(tens>=7){
            String result = "C";
            return result;
        } else if(tens>=6){
            return "D";
        } else {
            return "F";
        }
    }

    public static void main(String[] args) {
        String result = letter(98);
        System.out.println(result);
        result = letter(75);
        System.out.println(result);
        result = letter(30);
        System.out.println(result);
    }
}
```



When a method returns:

- Follow the return arrow and assign the returned value
- Cross out the stack frame - it is deleted from memory

```java
package week1;

public class PlusMinus {
    public static String letter(int score){
        int tens=score/10;
        if (tens>=9){
            return "A";
        } else if(tens>=8){
            return "B";
        } else if(tens>=7){
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        } else {
            return "F";
        }
    }

    public static void main(String[] args) {
        String result = letter(98);
        System.out.println(result);
        result = letter(75);
        System.out.println(result);
        result = letter(30);
        System.out.println(result);
    }
}
```

Stack

Name	Value
result	"A"
~~score~~	~~98~~
~~tens~~	~~9~~

letter

Heap

in/out

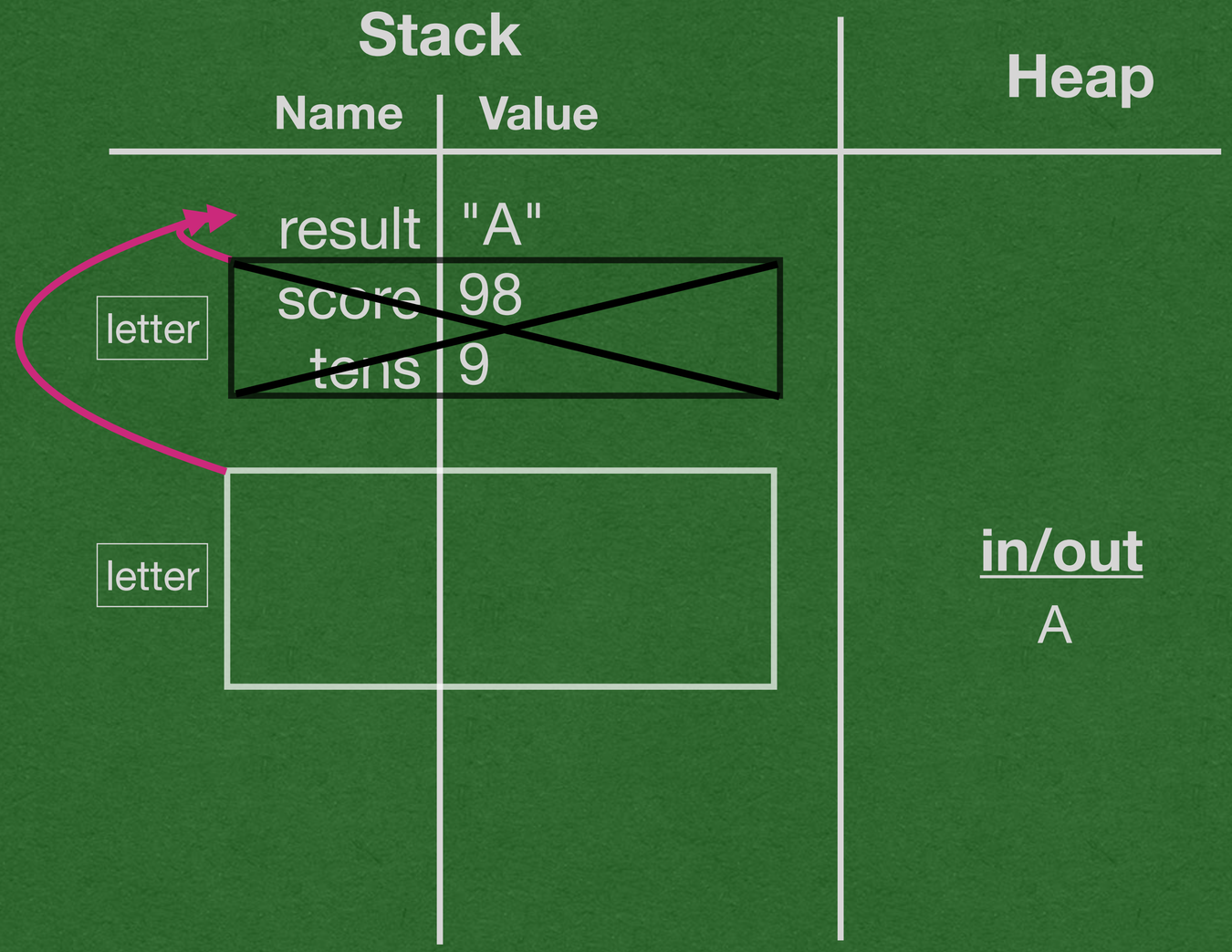
A

- Print the value stored in result

```java
package week1;

public class PlusMinus {
    public static String letter(int score){
        int tens=score/10;
        if (tens>=9){
            return "A";
        } else if(tens>=8){
            return "B";
        } else if(tens>=7){
            String result = "C";
            return result;
        } else if(tens>=6){
            return "D";
        } else {
            return "F";
        }
    }

    public static void main(String[] args) {
        String result = letter(98);
        System.out.println(result);
        result = letter(75);
        System.out.println(result);
        result = letter(30);
        System.out.println(result);
    }
}
```

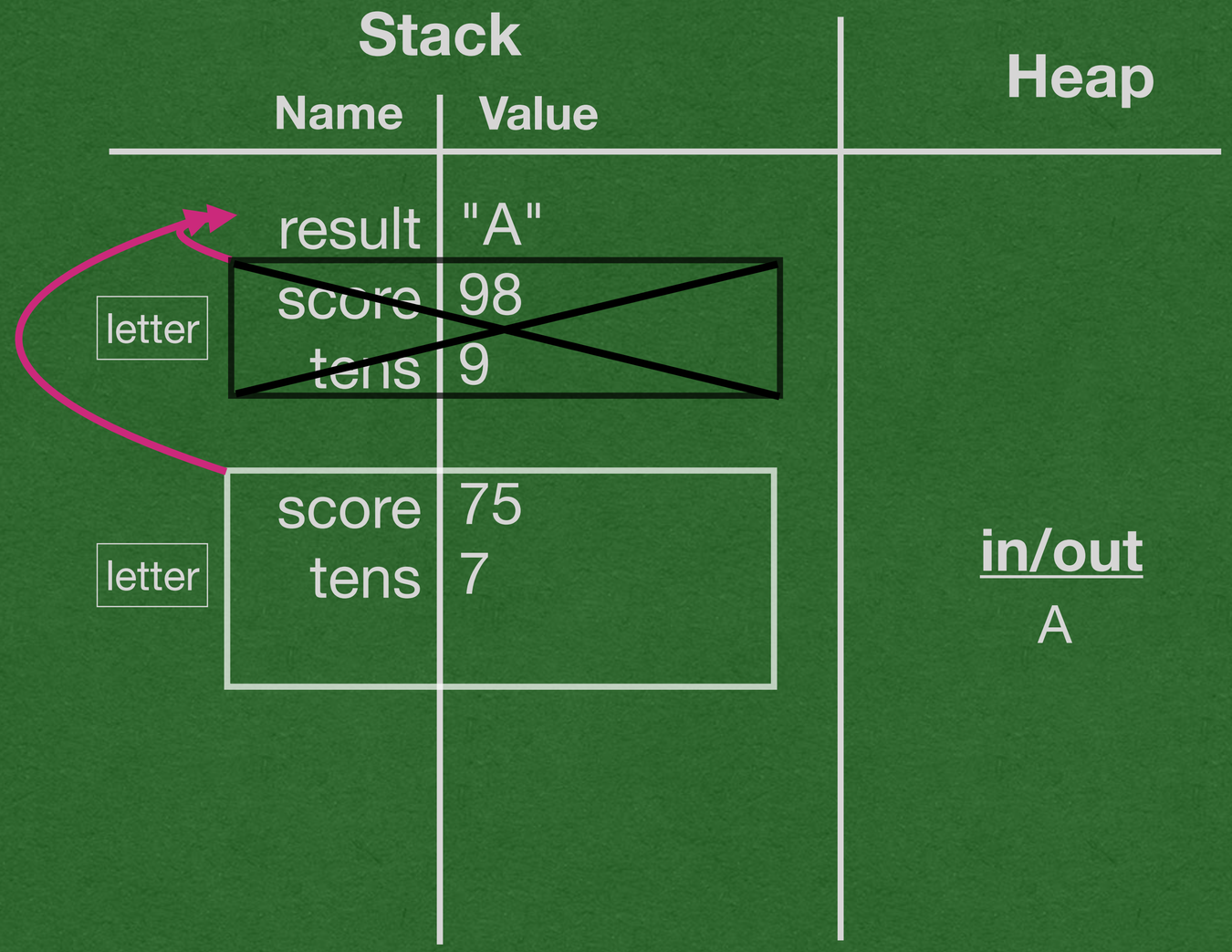


- Do it all again with an argument of 75
- Set up the stack frame

```java
package week1;

public class PlusMinus {
    public static String letter(int score){
        int tens=score/10;
        if (tens>=9){
            return "A";
        } else if(tens>=8){
            return "B";
        } else if(tens>=7){
            String result = "C";
            return result;
        } else if(tens>=6){
            return "D";
        } else {
            return "F";
        }
    }

    public static void main(String[] args) {
        String result = letter(98);
        System.out.println(result);
        result = letter(75);
        System.out.println(result);
        result = letter(30);
        System.out.println(result);
    }
}
```



- Add the parameter to the stack frame
- Declare "tens" inside the stack frame

```java
package week1;

public class PlusMinus {
    public static String letter(int score){
        int tens=score/10;
        if (tens>=9){
            return "A";
        } else if(tens>=8){
            return "B";
        } else if(tens>=7){
            String result = "C";
            return result;
        } else if(tens>=6){
            return "D";
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            return "F";
        }
    }

    public static void main(String[] args) {
        String result = letter(98);
        System.out.println(result);
        result = letter(75);
        System.out.println(result);
        result = letter(30);
        System.out.println(result);
    }
}
```

Stack

Name	Value
result	"A"
letter score	98
letter tens	9
letter score	75
letter tens	7

Heap

in/out

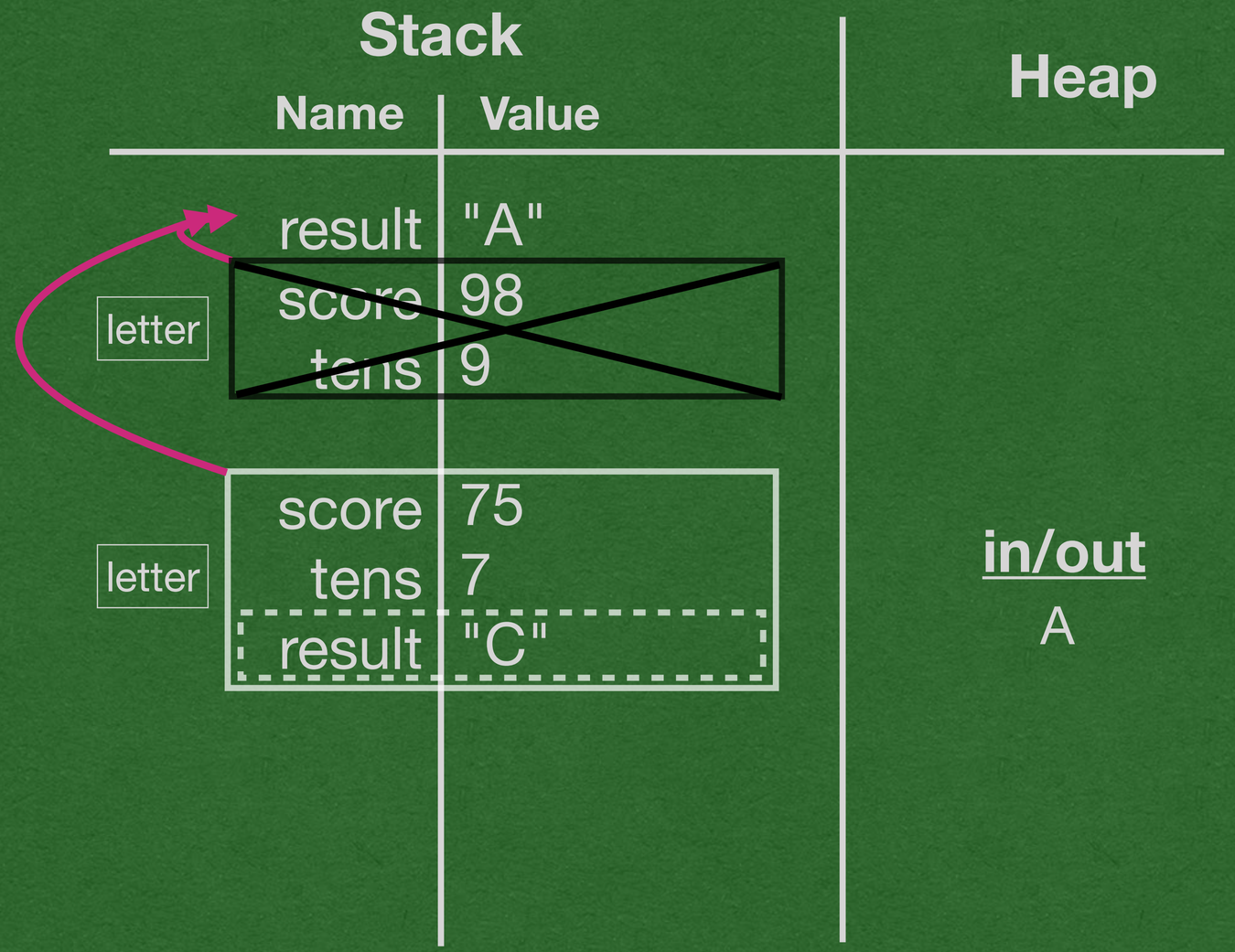
A

- First two boolean expressions resolve to false
- Third expression resolves to true
- Enter the third code block

```java
package week1;

public class PlusMinus {
    public static String letter(int score){
        int tens=score/10;
        if (tens>=9){
            return "A";
        } else if(tens>=8){
            return "B";
        } else if(tens>=7){
            String result = "C";
            return result;
        } else if(tens>=6){
            return "D";
        } else {
            return "F";
        }
    }

    public static void main(String[] args) {
        String result = letter(98);
        System.out.println(result);
        result = letter(75);
        System.out.println(result);
        result = letter(30);
        System.out.println(result);
    }
}
```

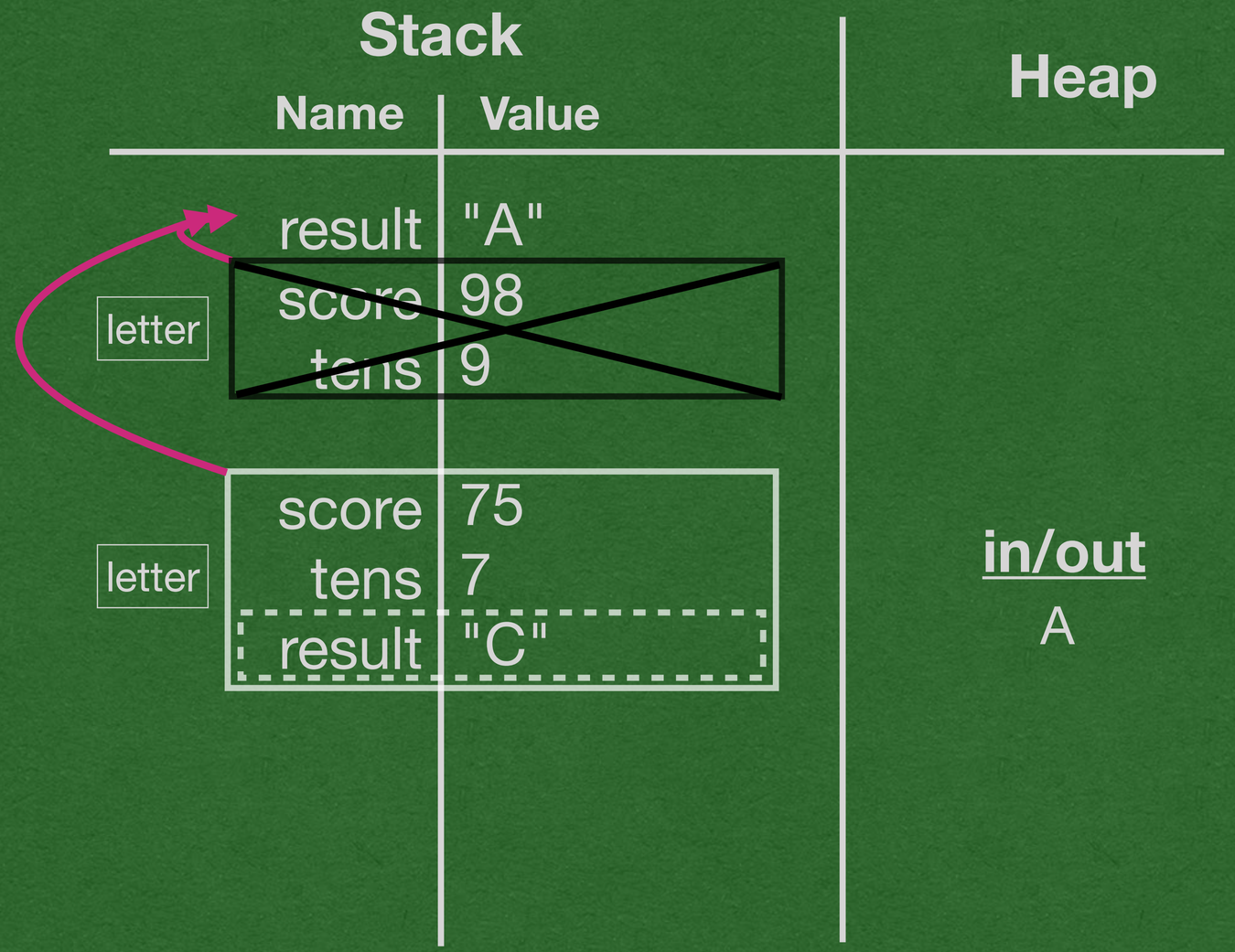


- When a variable is declared inside a code block:
  - Add the code block to the stack
  - Add the variable inside the code block

```java
package week1;

public class PlusMinus {
    public static String letter(int score){
        int tens=score/10;
        if (tens>=9){
            return "A";
        } else if(tens>=8){
            return "B";
        } else if(tens>=7){
            String result = "C";
            return result;
        } else if(tens>=6){
            return "D";
        } else {
            return "F";
        }
    }

    public static void main(String[] args) {
        String result = letter(98);
        System.out.println(result);
        result = letter(75);
        System.out.println(result);
        result = letter(30);
        System.out.println(result);
    }
}
```



- Code block are represented by dashed boxes
- Variables outside the code block can still accessed

```java
package week1;

public class PlusMinus {
    public static String letter(int score){
        int tens=score/10;
        if (tens>=9){
            return "A";
        } else if(tens>=8){
            return "B";
        } else if(tens>=7){
            String result = "C";
            return result;
        } else if(tens>=6){
            return "D";
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        }
    }

    public static void main(String[] args) {
        String result = letter(98);
        System.out.println(result);
        result = letter(75);
        System.out.println(result);
        result = letter(30);
        System.out.println(result);
    }
}
```

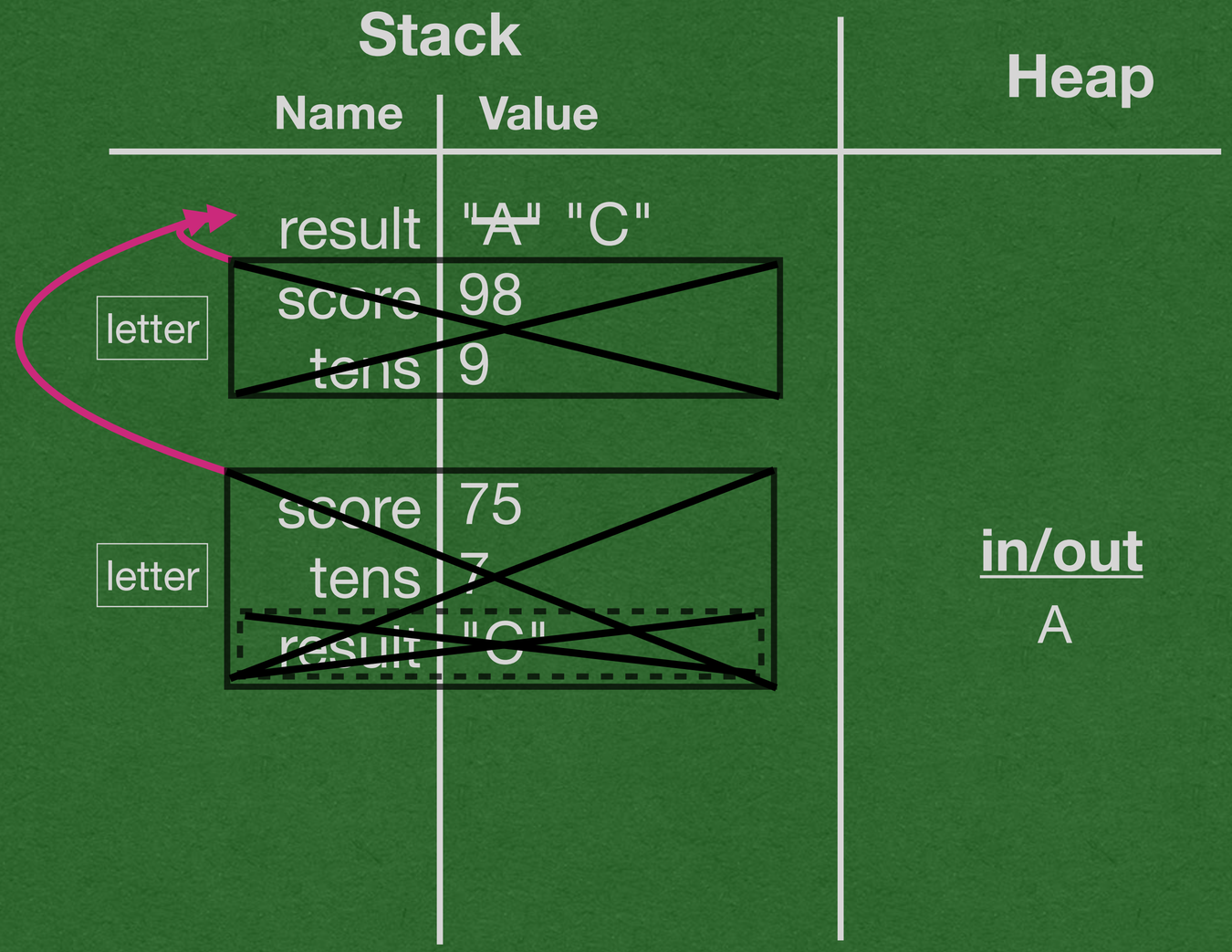

- Return result into result (!)
- The method and code block both end
- Cross out both

```java
package week1;

public class PlusMinus {
    public static String letter(int score){
        int tens=score/10;
        if (tens>=9){
            return "A";
        } else if(tens>=8){
            return "B";
        } else if(tens>=7){
            String result = "C";
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        }
    }

    public static void main(String[] args) {
        String result = letter(98);
        System.out.println(result);
        result = letter(75);
        System.out.println(result);
        result = letter(30);
        System.out.println(result);
    }
}
```

Stack

	Name	Value
	result	~~"A"~~ "C"
letter	~~score~~	~~98~~
	~~tens~~	~~9~~
letter	~~score~~	~~75~~
	~~tens~~	~~7~~
	~~result~~	~~"C"~~

Heap

in/out

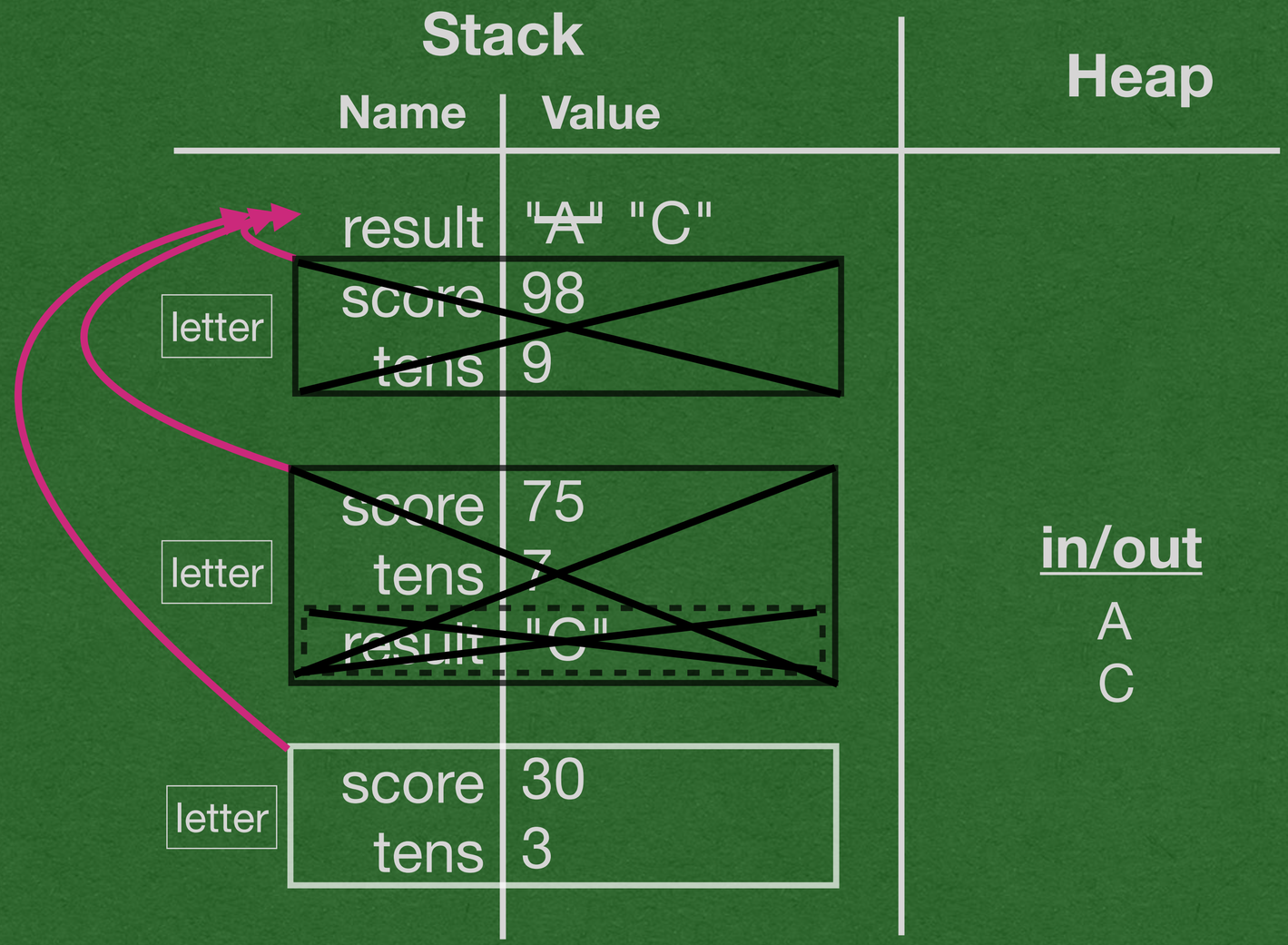
A
C

- Print "C"

```java
package week1;

public class PlusMinus {
    public static String letter(int score){
        int tens=score/10;
        if (tens>=9){
            return "A";
        } else if(tens>=8){
            return "B";
        } else if(tens>=7){
            String result = "C";
            return result;
        } else if(tens>=6){
            return "D";
        } else {
            return "F";
        }
    }

    public static void main(String[] args) {
        String result = letter(98);
        System.out.println(result);
        result = letter(75);
        System.out.println(result);
        result = letter(30);
        System.out.println(result);
    }
}
```

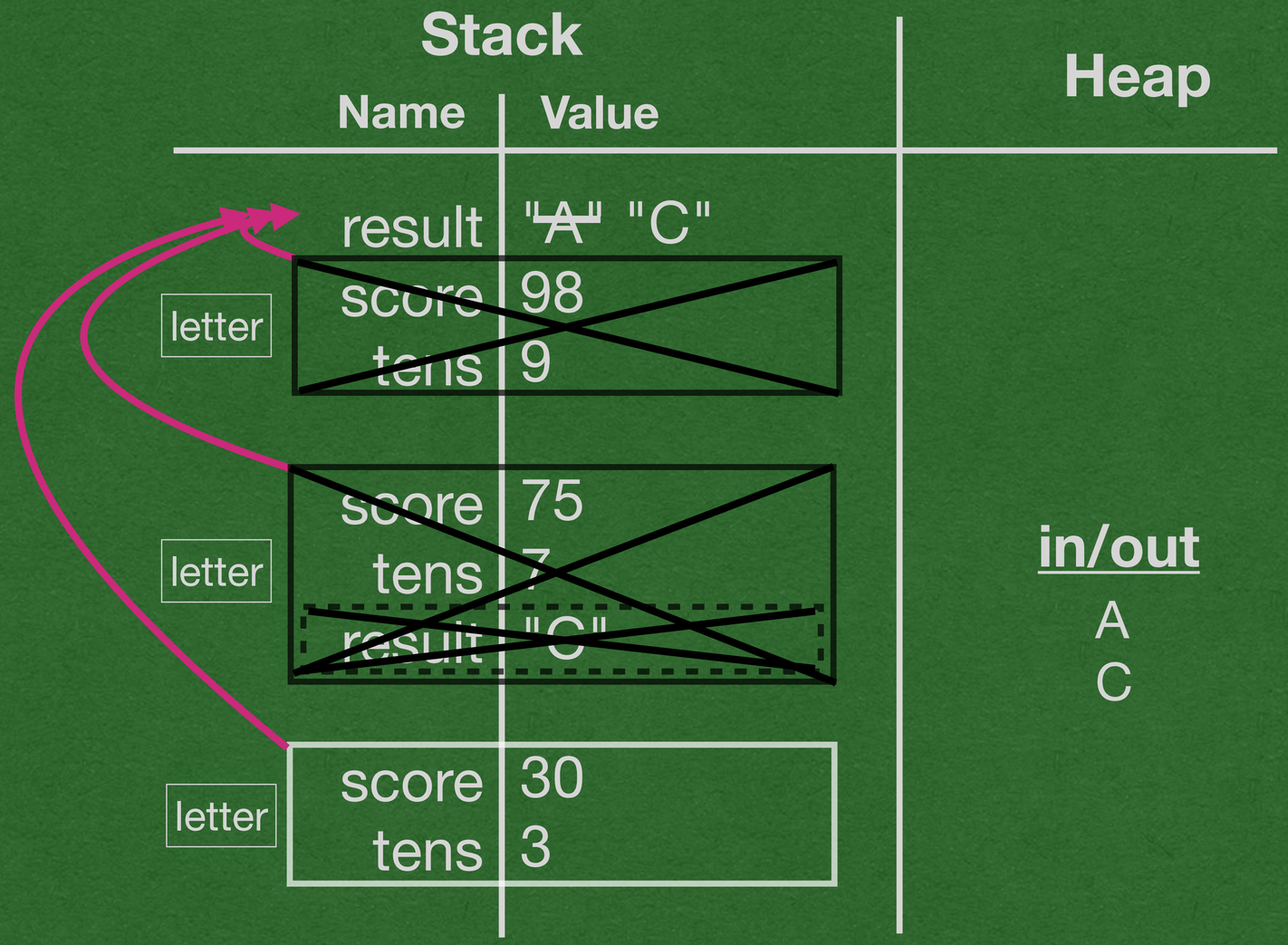


- I'll do it again.

```java
package week1;

public class PlusMinus {
    public static String letter(int score){
        int tens=score/10;
        if (tens>=9){
            return "A";
        } else if(tens>=8){
            return "B";
        } else if(tens>=7){
            String result = "C";
            return result;
        } else if(tens>=6){
            return "D";
        } else {
            return "F";
        }
    }

    public static void main(String[] args) {
        String result = letter(98);
        System.out.println(result);
        result = letter(75);
        System.out.println(result);
        result = letter(30);
        System.out.println(result);
    }
}
```

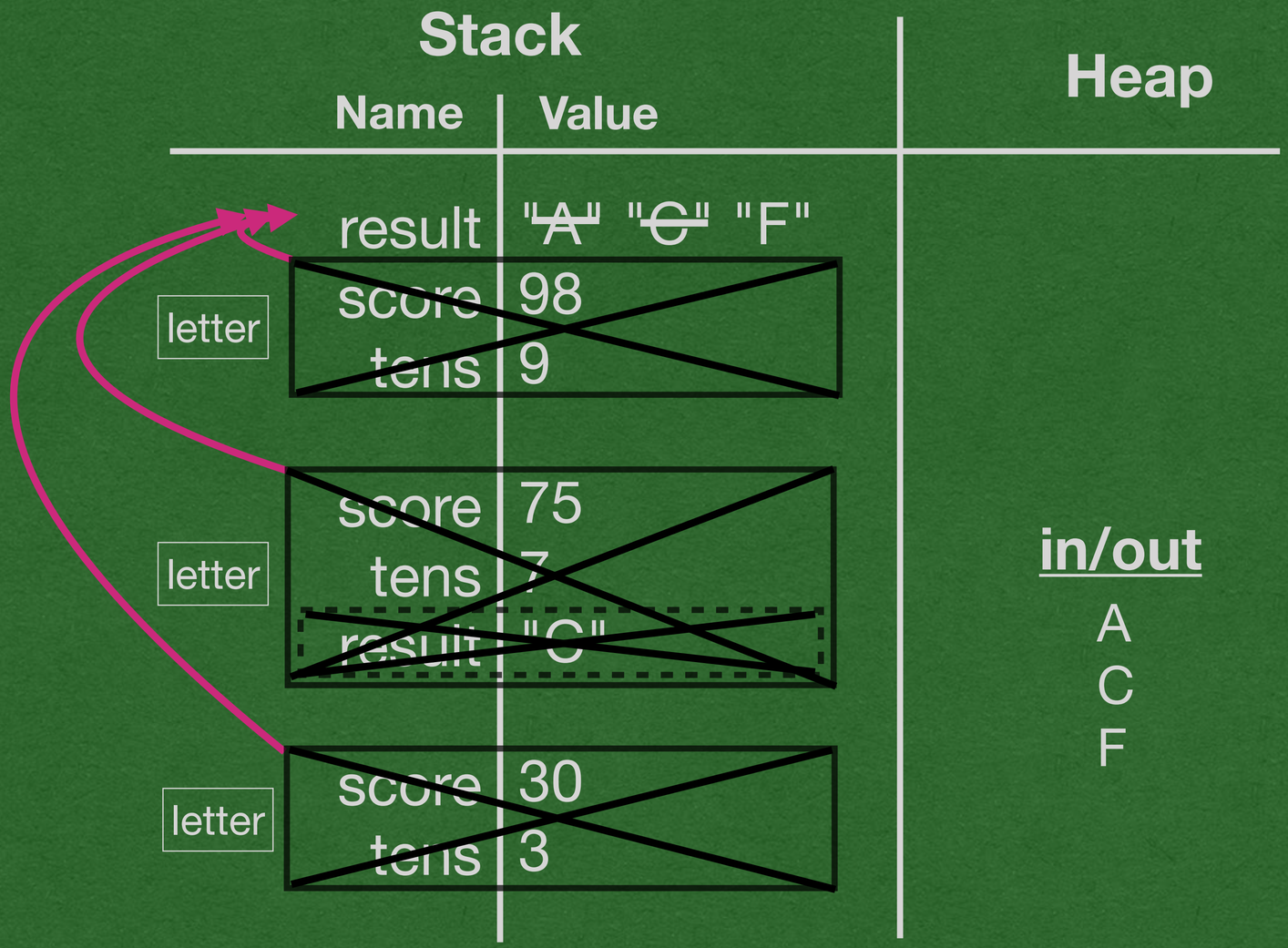


- All boolean expressions are false
- We hit the else block
- No variables are declared in the block so we don't draw a dashed box (It would be empty, so why bother)

```java
package week1;

public class PlusMinus {
    public static String letter(int score){
        int tens=score/10;
        if (tens>=9){
            return "A";
        } else if(tens>=8){
            return "B";
        } else if(tens>=7){
            String result = "C";
            return result;
        } else if(tens>=6){
            return "D";
        } else {
            return "F";
        }
    }

    public static void main(String[] args) {
        String result = letter(98);
        System.out.println(result);
        result = letter(75);
        System.out.println(result);
        result = letter(30);
        System.out.println(result);
    }
}
```



- Print one last time
- Program ends

Loops

Java - While Loop

```java
double val = 10;
while (val > 1) {
    System.out.println(val);
    val /= 2;
}
```

- Same syntax as a conditional
- Except: The code block executes **until** the boolean expression is false
- This loop runs until val <= 1

Java - While Loop

```java
double val = -5;
while (val > 1) {
    System.out.println(val);
    val /= 2;
}
```

- While loops might not run at all
- If val is initialized to -5, the boolean expression is false and the body of the loop never executes

Java - For Loop

```
for (int x=0; x<5; x++) {
    System.out.println(x);
}
```

- The for loop is similar to a while loop, but with additional power
- This loop executes while x<5
- When the loop is first reached, the variable x is declared and assigned 0
- **Each time** the end of the code block is reached, x is incremented by 1
  - "x++" is equivalent to "x = x+1"

Java - For Loop

```
for (<initialization>; <boolean_expression>; <increment>) {
    <loop_body>
}
```

- A for loop is composed of 4 separate statements
- <initialization>: Runs only once when the loop first starts
- <boolean_expression>: loop_body executes while this resolves to true
- <increment>: Executes after each iteration of the loop (at the end of loop_body)

Memory Diagram 😃

```java
package week1;

public class Loops {
    public static void main(String[] args) {
        double val = 10.0;
        while (val > 1) {
            System.out.println(val);
            val /= 2;
        }

        for (int x=0; x<5; x++) {
            System.out.println(x);
        }
    }
}
```

Stack		Heap
Name	Value	
val	10.0	in/out

- Let's see these loops in action!
- Initialize val to 10

```java
package week1;

public class Loops {
    public static void main(String[] args) {
        double val = 10.0;
        while (val > 1) {
            System.out.println(val);
            val /= 2;
        }

        for (int x=0; x<5; x++) {
            System.out.println(x);
        }
    }
}
```

Stack		Heap
Name	Value	
val	10.0	in/out

- Check the condition of the while loop
- 10 > 1 == true so the loop body executes
- No variables are declared inside the loop so we don't draw a dashed box

```java
package week1;

public class Loops {
    public static void main(String[] args) {
        double val = 10.0;
        while (val > 1) {
            System.out.println(val);
            val /= 2;
        }

        for (int x=0; x<5; x++) {
            System.out.println(x);
        }
    }
}
```

Stack

Name	Value
val	~~10.0~~ 5.0

Heap

in/out

10.0

- Print 10
- "val /= 2" is another shortcut that mean "val = val / 2"
  - Same applies for +=, -=, *=

```java
package week1;

public class Loops {
    public static void main(String[] args) {
        double val = 10.0;
        while (val > 1) {
            System.out.println(val);
            val /= 2;
        }

        for (int x=0; x<5; x++) {
            System.out.println(x);
        }
    }
}
```

Stack

Name	Value
val	~~10.0~~ 5.0

Heap

in/out

10.0

- We reach the end of the body of the while loop
- Check the boolean expression again

```java
package week1;

public class Loops {
    public static void main(String[] args) {
        double val = 10.0;
        while (val > 1) {
            System.out.println(val);
            val /= 2;
        }

        for (int x=0; x<5; x++) {
            System.out.println(x);
        }
    }
}
```

Stack

Name	Value
val	~~10.0~~ ~~5.0~~ 2.5

Heap

in/out

10.0
5.0

- Since 5 > 1, we run the body again
- We avoid integer division since val is a double

```java
package week1;

public class Loops {
    public static void main(String[] args) {
        double val = 10.0;
        while (val > 1) {
            System.out.println(val);
            val /= 2;
        }

        for (int x=0; x<5; x++) {
            System.out.println(x);
        }
    }
}
```

Stack

Name	Value
val	~~10.0~~ ~~5.0~~ 2.5

Heap

in/out

10.0
5.0

- Check the expression again
- 2.5 > 1 == true means we're going around again

```java
package week1;

public class Loops {
    public static void main(String[] args) {
        double val = 10.0;
        while (val > 1) {
            System.out.println(val);
            val /= 2;
        }

        for (int x=0; x<5; x++) {
            System.out.println(x);
        }
    }
}
```

Stack

Name	Value
val	~~10.0~~ ~~5.0~~ ~~2.5~~ 1.25

Heap

in/out

10.0
5.0
2.5

- Print and divide

```java
package week1;

public class Loops {
    public static void main(String[] args) {
        double val = 10.0;
        while (val > 1) {
            System.out.println(val);
            val /= 2;
        }

        for (int x=0; x<5; x++) {
            System.out.println(x);
        }
    }
}
```

Stack

Name	Value
val	~~10.0~~ ~~5.0~~ ~~2.5~~ 1.25

Heap

in/out

10.0
5.0
2.5

- 1.25 > 1 == true
- Why does this example loop so many times..

```java
package week1;

public class Loops {
    public static void main(String[] args) {
        double val = 10.0;
        while (val > 1) {
            System.out.println(val);
            val /= 2;
        }

        for (int x=0; x<5; x++) {
            System.out.println(x);
        }
    }
}
```

Stack

Name	Value
val	~~10.0~~ ~~5.0~~ ~~2.5~~ ~~1.25~~ 0.625

Heap

in/out

10.0
5.0
2.5
1.25

- Print and divide

```java
package week1;

public class Loops {
    public static void main(String[] args) {
        double val = 10.0;
        while (val > 1) {
            System.out.println(val);
            val /= 2;
        }

        for (int x=0; x<5; x++) {
            System.out.println(x);
        }
    }
}
```

Stack

Name	Value
val	~~10.0~~ ~~5.0~~ ~~2.5~~ ~~1.25~~ 0.625

Heap

in/out

10.0
5.0
2.5
1.25

- Check the boolean expression again
- This time, 0.625 > 1 == false
- The loop ends

```java
package week1;

public class Loops {
    public static void main(String[] args) {
        double val = 10.0;
        while (val > 1) {
            System.out.println(val);
            val /= 2;
        }

        for (int x=0; x<5; x++) {
            System.out.println(x);
        }
    }
}
```

Stack

Name	Value
val	~~10.0~~ ~~5.0~~ ~~2.5~~ ~~1.25~~ 0.625

Heap

in/out

10.0
5.0
2.5
1.25

- Since val was declared outside the loop, it remains in memory after the loops ends

```java
package week1;

public class Loops {
    public static void main(String[] args) {
        double val = 10.0;
        while (val > 1) {
            System.out.println(val);
            val /= 2;
        }

        for (int x=0; x<5; x++) {
            System.out.println(x);
        }
    }
}
```

Stack

Name	Value
val	~~10.0~~ ~~5.0~~ ~~2.5~~ ~~1.25~~ 0.625
x	0

Heap

in/out

10.0
5.0
2.5
1.25

- When we reach a for loop, first execute the initialization statement
- If a variable is declared, it is inside the code block on the stack

```java
package week1;

public class Loops {
    public static void main(String[] args) {
        double val = 10.0;
        while (val > 1) {
            System.out.println(val);
            val /= 2;
        }

        for (int x=0; x<5; x++) {
            System.out.println(x);
        }
    }
}
```

Stack

Name	Value
val	~~10.0~~ ~~5.0~~ ~~2.5~~ ~~1.25~~ 0.625
x	0

Heap

in/out

10.0
5.0
2.5
1.25

- Check the conditional: 0<5 == true so the loop executes
- Note that if this were false, the loop body would never run

```java
package week1;

public class Loops {
    public static void main(String[] args) {
        double val = 10.0;
        while (val > 1) {
            System.out.println(val);
            val /= 2;
        }

        for (int x=0; x<5; x++) {
            System.out.println(x);
        }
    }
}
```

Stack

Name	Value
val	~~10.0~~ ~~5.0~~ ~~2.5~~ ~~1.25~~ 0.625
x	0

Heap

in/out
10.0
5.0
2.5
1.25
0

- Print x

```java
package week1;

public class Loops {
    public static void main(String[] args) {
        double val = 10.0;
        while (val > 1) {
            System.out.println(val);
            val /= 2;
        }

        for (int x=0; x<5; x++) {
            System.out.println(x);
        }
    }
}
```

Stack

Name	Value
val	~~10.0~~ ~~5.0~~ ~~2.5~~ ~~1.25~~ 0.625
x	~~0~~ 1

Heap

in/out
10.0
5.0
2.5
1.25
0

- When we reach the end of the loop body, run the increment statement

```java
package week1;

public class Loops {
    public static void main(String[] args) {
        double val = 10.0;
        while (val > 1) {
            System.out.println(val);
            val /= 2;
        }

        for (int x=0; x<5; x++) {
            System.out.println(x);
        }
    }
}
```

Stack

Name	Value
val	~~10.0~~ ~~5.0~~ ~~2.5~~ ~~1.25~~ 0.625
x	~~0~~ 1

Heap

in/out

10.0
5.0
2.5
1.25
0

- Then, check the condition again
- 1<5 == true so we run the body again

```java
package week1;

public class Loops {
    public static void main(String[] args) {
        double val = 10.0;
        while (val > 1) {
            System.out.println(val);
            val /= 2;
        }

        for (int x=0; x<5; x++) {
            System.out.println(x);
        }
    }
}
```

Stack

Name	Value
val	~~10.0~~ ~~5.0~~ ~~2.5~~ ~~1.25~~ 0.625
x	~~0~~ ~~1~~ 2

Heap

in/out
10.0
5.0
2.5
1.25
0
1

- Print x
- We increments x (Run x++) each time we reach the end of the loop body

```java
package week1;

public class Loops {
    public static void main(String[] args) {
        double val = 10.0;
        while (val > 1) {
            System.out.println(val);
            val /= 2;
        }

        for (int x=0; x<5; x++) {
            System.out.println(x);
        }
    }
}
```

Stack

Name	Value
val	~~10.0~~ ~~5.0~~ ~~2.5~~ ~~1.25~~ 0.625
x	~~0~~ ~~1~~ ~~2~~ ~~3~~ 4

Heap

in/out
10.0
5.0
2.5
1.25
0
1
2
3
4

- Let's jump forward to the point where x == 4 and we just printed 4 to the screen

```java
package week1;

public class Loops {
    public static void main(String[] args) {
        double val = 10.0;
        while (val > 1) {
            System.out.println(val);
            val /= 2;
        }

        for (int x=0; x<5; x++) {
            System.out.println(x);
        }
    }
}
```

Stack

Name	Value
val	~~10.0~~ ~~5.0~~ ~~2.5~~ ~~1.25~~ 0.625
x	~~0~~ ~~1~~ ~~2~~ ~~3~~ ~~4~~ 5

Heap

in/out
10.0
5.0
2.5
1.25
0
1
2
3
4

- We reach the end of the loop body and run x++ to increment it to 5

```java
package week1;

public class Loops {
    public static void main(String[] args) {
        double val = 10.0;
        while (val > 1) {
            System.out.println(val);
            val /= 2;
        }

        for (int x=0; x<5; x++) {
            System.out.println(x);
        }
    }
}
```

Stack

Name	Value
val	~~10.0~~ ~~5.0~~ ~~2.5~~ ~~1.25~~ 0.625
x	~~0~~ ~~1~~ ~~2~~ ~~3~~ ~~4~~ 5

Heap

in/out

10.0
5.0
2.5
1.25
0
1
2
3
4

- This time, 5<5 == false
- The loop ends

```java
package week1;

public class Loops {
    public static void main(String[] args) {
        double val = 10.0;
        while (val > 1) {
            System.out.println(val);
            val /= 2;
        }

        for (int x=0; x<5; x++) {
            System.out.println(x);
        }
    }
}
```

Stack

Name	Value
val	~~10.0~~ ~~5.0~~ ~~2.5~~ ~~1.25~~ 0.625
~~x~~	~~0 1 2 3 4 5~~

Heap

in/out
10.0
5.0
2.5
1.25
0
1
2
3
4

- Whenever a code block ends, cross it out
- The variable x is no longer in memory after the loop ends

```java
package week1;

public class Loops {
    public static void main(String[] args) {
        double val = 10.0;
        while (val > 1) {
            System.out.println(val);
            val /= 2;
        }

        for (int x=0; x<5; x++) {
            System.out.println(x);
        }
    }
}
```

Stack

Name	Value
val	~~10.0~~ ~~5.0~~ ~~2.5~~ ~~1.25~~ 0.625
~~x~~	~~0~~ ~~1~~ ~~2~~ ~~3~~ ~~4~~ ~~5~~

Heap

in/out
10.0
5.0
2.5
1.25
0
1
2
3
4

- The program ends