# While and Do-While Loops

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# Loops

- Within a method, we can alter the *flow of control* using either conditionals or loops.
- The *loop statements* **`while`**, **`do-while`**, and **`for`** allow us execute a statement(s) over and over.
- Like a conditional, a loop is controlled by a boolean expression that determines how many times the statement is executed.

E.g., You may want to calculate the interest paid on a mortgage for each year of the loan term.

# The `while` statement

- The form of the **`while`** statement is

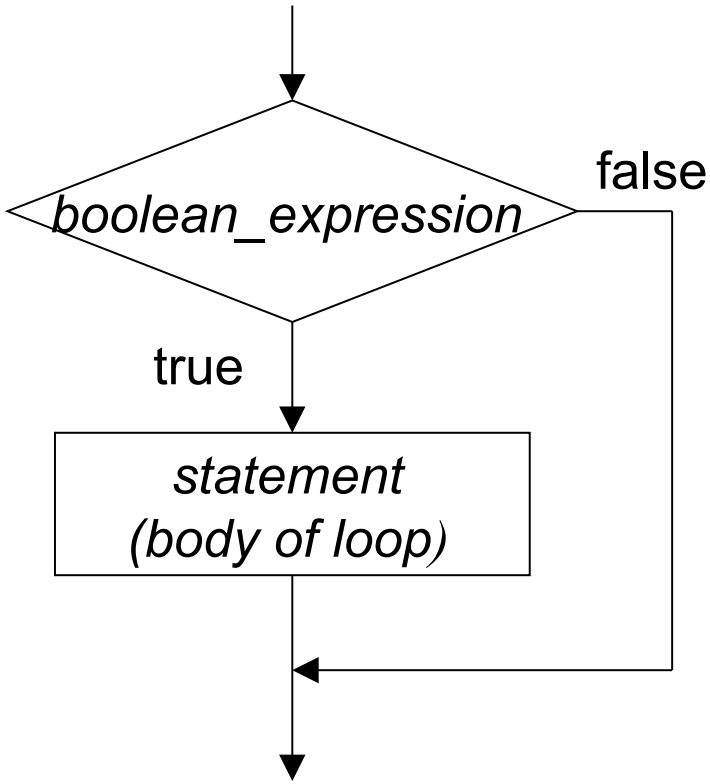
  **`while`** (<*boolean_expression*>)

  <*statement*>

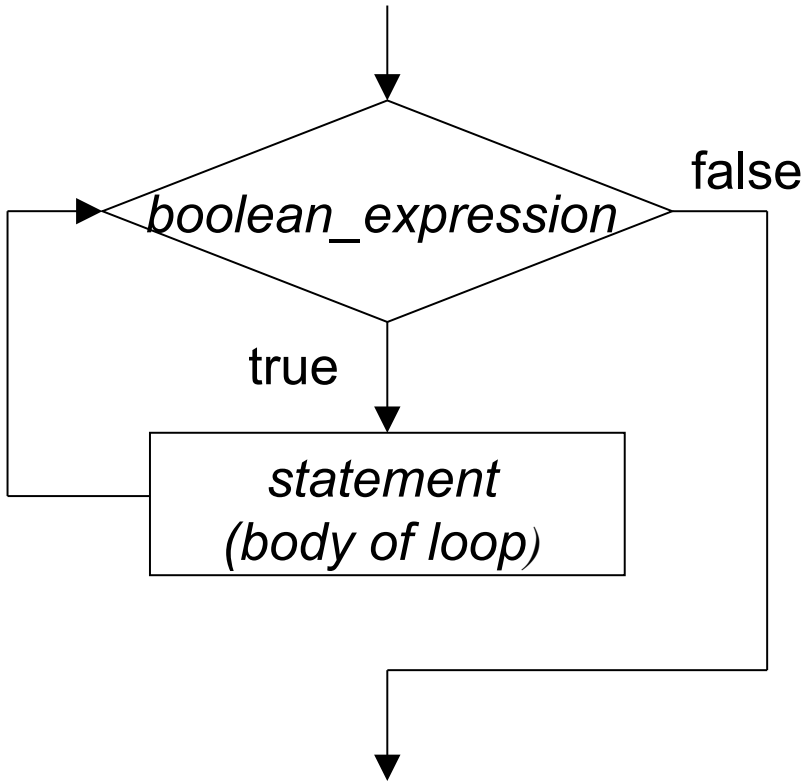
- If *boolean_expression* evaluates to `true`, then *statement* is executed.
- Then, the *boolean_expression* is evaluated again. If it evaluates to `true`, *statement* is executed again.
- This repetition continues until the *boolean_expression* evaluates to `false`.

*How is the while loop different from the if statement?*

# The `if` Flowchart



# The `while` Flowchart



# A `while` Example

Print n asterisks

```
int i = 0;
while (i < n) {
   System.out.print("*");
   i++;
}
System.out.println();
```

n = 5

| | i | output |
|---|---|---|
| i < n ? | 0 | |
| | | * |
| i < n ? | 1 | |
| | | ** |
| i < n ? | 2 | |
| | | *** |
| i < n ? | 3 | |
| | | **** |
| i < n ? | 4 | |
| | | ***** |
| i < n ? | 5 | |
| | | *****\n |

# The `Loop Control Variable`

- The variable `i` (known as the *loop control variable*) is used in three ways: it is ***initialized***, ***tested***, and ***updated***.

```
int i = 0;          // initialize
while (i < n) {     // test
    System.out.print("*");
    i++;            // update
}
System.out.println();
```

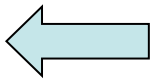
- All three things must be coordinated in order for the loop to work correctly!

# Off-by-1 Errors

```
int i = 0;
while (i < n) {
   System.out.print("*");
   i++;
}
System.out.println();
```

For n = 5 the output is

***** (5 asterisks)



```
int i = 1;
while (i < n) {
    System.out.print
("*");
    i++;
}
System.out.println();
```

Output?

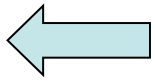
# Off-by-1 Errors

```
int i = 0;
while (i < n) {
   System.out.print("*");
   i++;
}
System.out.println();
```

For n = 5 the output is

***** (5 asterisks)

```
int i = 0;
while (i <= n) {
    System.out.print
("*");
    i++;
}
System.out.println();
```



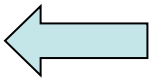
Output?

# Warning!

```
int i = 0;
while (i < n) {

   System.out.print("*");
   i--;
}
System.out.println();
```

*What is the output if n = 5?*



# Infinite Loops

```
int i = 0;
while (i < n) {

   System.out.print("*");
   i--;
}
System.out.println();
```

Do you know which company has this address?

Apple Computer
1 **Infinite Loop**
Cupertino, CA 95014

# A `while` Example

```
int i = 0;
while (i < n) {
   System.out.print("*");
   i++;
}
System.out.println();
```

*What is the output if n = 0?*

# Exercise

- Write a method with a `while` loop to prints 1 through n in square brackets. For example, if n = 6 print

```
[1] [2] [3] [4] [5] [6]
```

# Exercise: Cumulative Sum

- Write a method with a `while` loop that computes the sum of first n positive integers:

  sum = 1 + 2 + 3 + … + n

  Examples:

  n = 5  sum = 15

  n = 19  sum = 190

# Exercise: Fencepost Loop

- Write a method with a `while` loop that prints 1 through n, separated by commas. E.g., for n = 9 print

```
1, 2, 3, 4, 5, 6, 7, 8, 9
```

# The `do` Statement

- The form of the **`do`** statement is

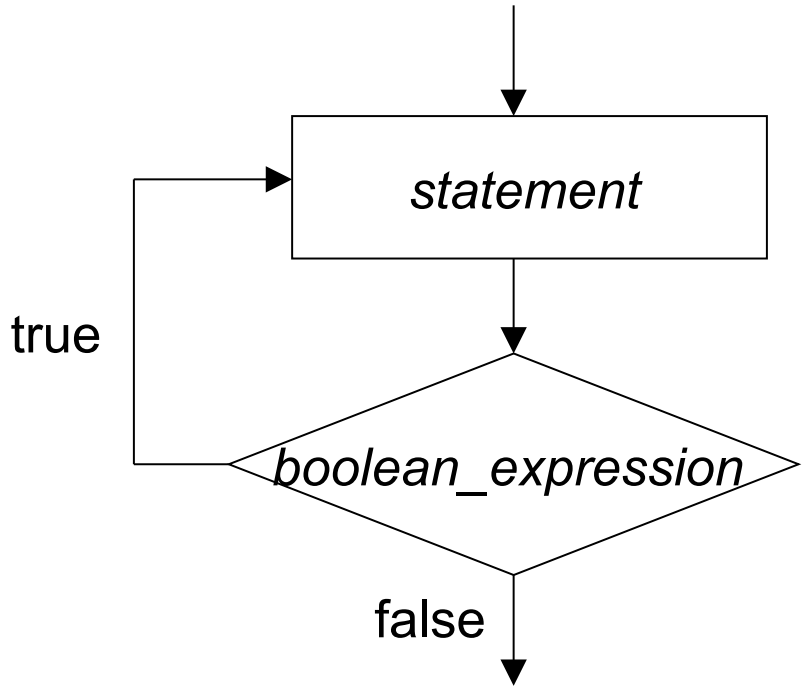
  **`do`**

  *<statement>*

  **`while`** (*<boolean_expression>*);

- First, *statement* is executed.
- Then, the *boolean_expression* is evaluated. If it evaluates to `true`, *statement* is executed again.
- This repetition continues until the *boolean_expression* evaluates to `false`.

# The do Flowchart



# Example

```
int i = 0;          // initialize
do {
    System.out.print("*");
    i++;            // update
} while (i < n); // test
System.out.println();
```

For n = 7 what is the output?

How is it different from the while loop?

# User Input

```
Scanner keyboard = new Scanner(System.in);
System.out.print(
      "Please enter the month [1-12]: ");
int month = keyboard.nextInt();
```

*What if the user enters a month outside the range?*

# User Input (cont'd)

- Use a do-while loop to test whether a user has entered data of the correct form and, if not, ask repeatedly until the data entered is correct.

```
Scanner keyboard = new Scanner(System.in);
int month;
do {
  System.out.print(
   "Please enter the month [1-12]: ");
  month = keyboard.nextInt();
} while ( month < 1 || month > 12 );
```

Must be declared outside the loop

Outside the scope of the loop

# User Input

- Sometimes it is easier to think of what you want the input to be and negate.

```
Scanner keyboard = new Scanner(System.in);
int month;
do {
   System.out.print(
       "Please enter the month [1-12]: ");
   month = keyboard.nextInt();
} while (!(month >= 1 && month <= 12));
```

What is the loop control variable?

Use de Morgan's law to prove the Boolean expressions are the same!

# Sentinel Controlled Loops

- Suppose you want to find the maximum of the data entered from the keyboard.
- It is not known in advanced how many data values a user might want to enter. (And the user may not want to count them!)
- A *sentinel* is a special value that is used to detect a special condition, in this case that the user is done entering values.
- The sentinel, of course, must be distinct from any value the user may want to input.

# Sentinel Example

```
Scanner console = new Scanner(System.in);
System.out.print("Enter count (enter -1 to quit): ");
int count = console.nextInt();
int maxSoFar = count;

while (count != -1) {
  if (count > maxSoFar) maxSoFar = count;

  System.out.print("Enter count (enter -1 to quit): ");
  count = console.nextInt();
}

if (maxSoFar > -1)
   System.out.println("The maximum is " + maxSoFar);
else
   System.out.println("No counts entered");
```

Consider making -1 a named constant