Lecture 03: Control Structures

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MISTI

Agenda

1. Block Statements
2. Decision Statements
3. Loops

What are Control Structures?

- Without control structures, a computer would evaluate all instructions in a program sequentially

- Allow you to control:
  - the order in which instructions are evaluated
  - which instructions are evaluated
  - the “flow” of the program

- Use pre-established code structures:
  - block statements (anything contained within curly brackets)
  - decision statements (if, if-else, switch)
  - Loops (for, while)

Block Statements

- Statements contained within curly brackets

```
{
  statement1;
  statement2;
}
```

- Evaluated sequentially when given instruction to “enter” curly brackets
- *Most basic control structure (building block of other control structures)*

Decision Statements: if-then

The “if” decision statement causes a program to execute a statement ***conditionally****

```
if (condition) {
  statement;
}
next_statement;
```

***Executes a statement when a condition is true**

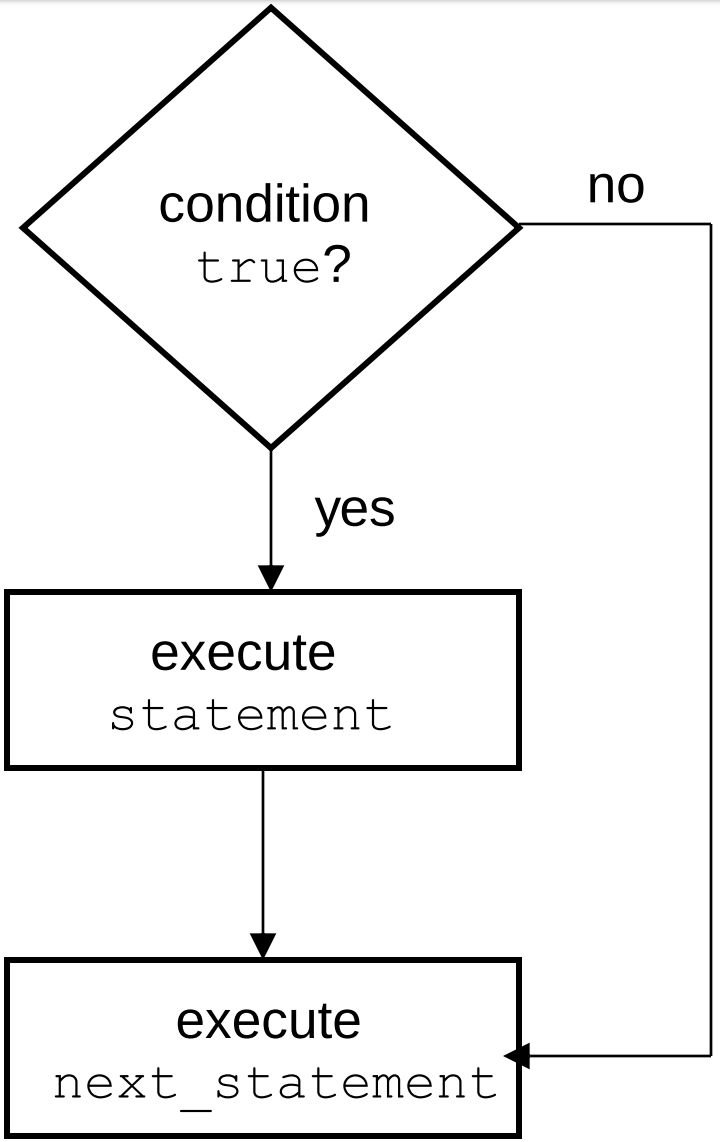
Dissecting if-then

```
if (condition) {
   statement;
  }
next_statement;
```

- The `condition` must produce either `true` or `false`, also known as a `boolean` value
- If `condition` returns `true`, `statement` is executed and then `next_statement`
- If `condition` returns `false`, `statement` is not executed and the program continues at `next_statement`

if-then Statement Flow Chart

```
if (condition) {
   statement;
}
next_statement;
```



if-then Example

```
int price = 5;

if (price > 3) {
  System.out.println(“Too expensive”);
}
//continue to next statement
```

Output:

Too expensive

if-then-else Statements

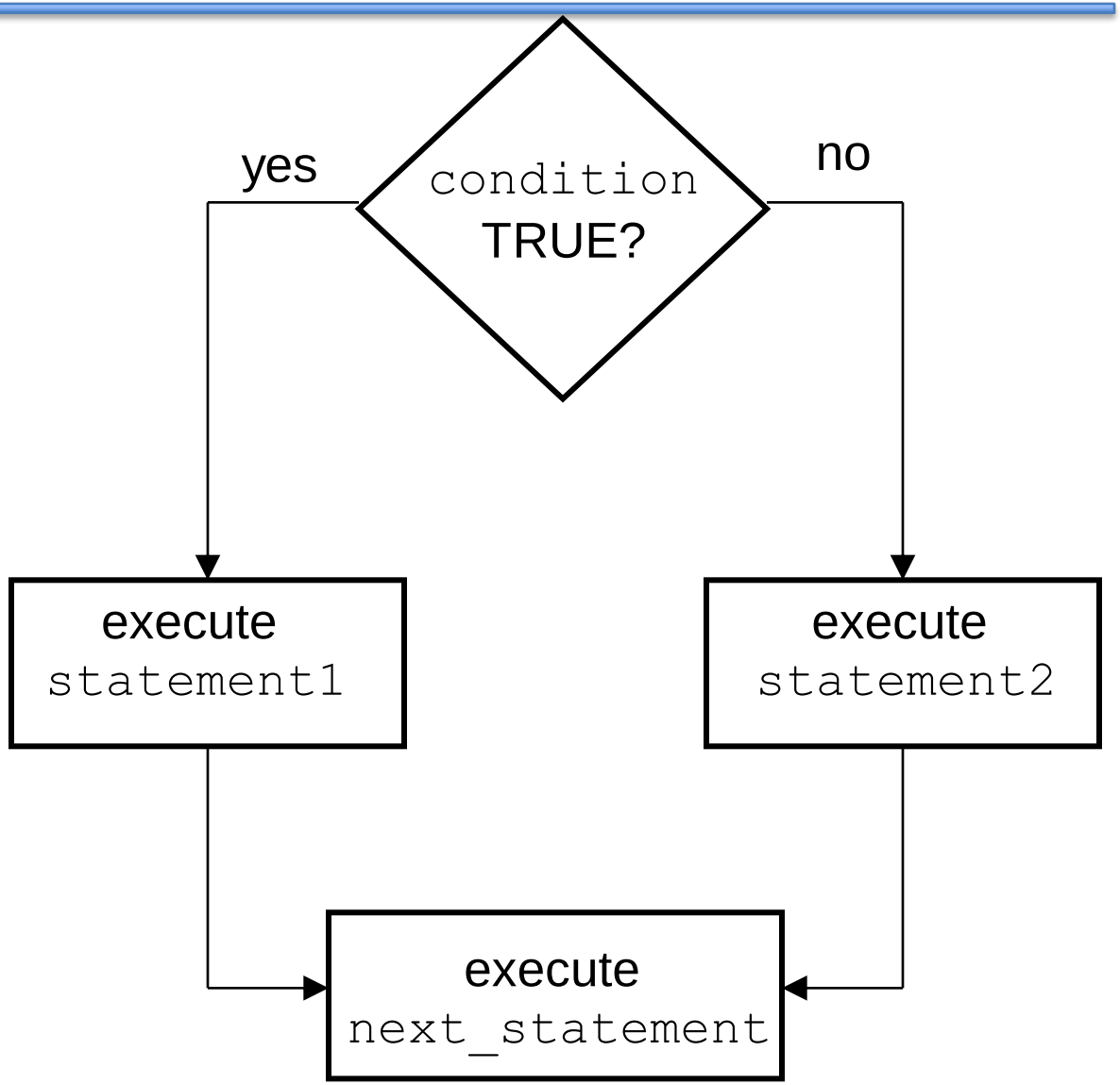
- The basic “if” statement can be extended by adding the “else” clause in order to do something if expression is false

```
if (condition) {
   statement1;
}
else {
   statement2;
}
next_statement;
```

- Again, the `condition` must produce a `boolean` value
- If `condition` returns `true`, `statement1` is executed and then `next_statement` is executed.
- If `condition` returns `false`, `statement2` is executed and then `next_statement` is executed.

if-then-else Statement Flow Chart

```
if (condition){
    statement1;
}
else {
    statement2;
}
next_statement;
```



if-then-else Example

```
int price = 2;

if (price > 3) {
  System.out.println(“Too expensive”);
}
else {
  System.out.println(“Good deal”);
}
//continue to next statement
```

Output:

Good deal

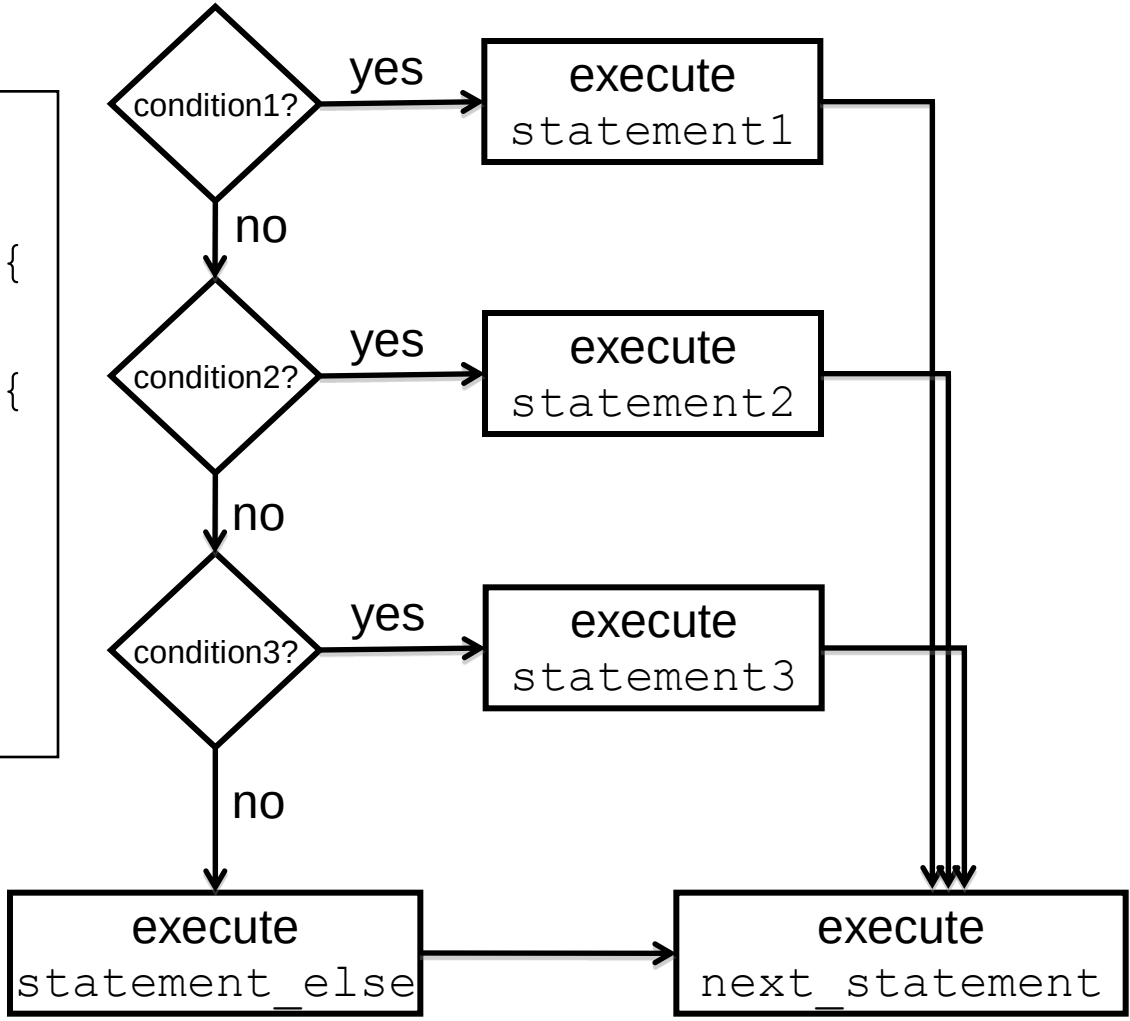
Chained if-then Statements

- Note that you can combine if-else statements below to make a chain to deal with more than one case

```
if (grade == 'A')
  System.out.println("You got an A.");
else if (grade == 'B')
  System.out.println("You got a B.");
else if (grade == 'C')
  System.out.println("You got a C.");
else
  System.out.println("You got an F.");
```

Chained if-then-else Statement Flow Chart

```
if (condition1) {
    statement1;
} else if (condition2) {
    statement2;
} else if (condition3) {
    statement3;
} else {
   statement_else;
}
next_statement;
```



switch Statements

- The `switch` statement is another way to test ***several cases*** generated by a given expression.

- The expression must produce a result of type `char`, `byte`, `short` or `int`, but not `long`, `float`, or `double`.

```
switch (expression) {

    case value1:
        statement1;
        break;

    case value2:
        statement2;
        break;

    default:
        default_statement;
        break;
}
```

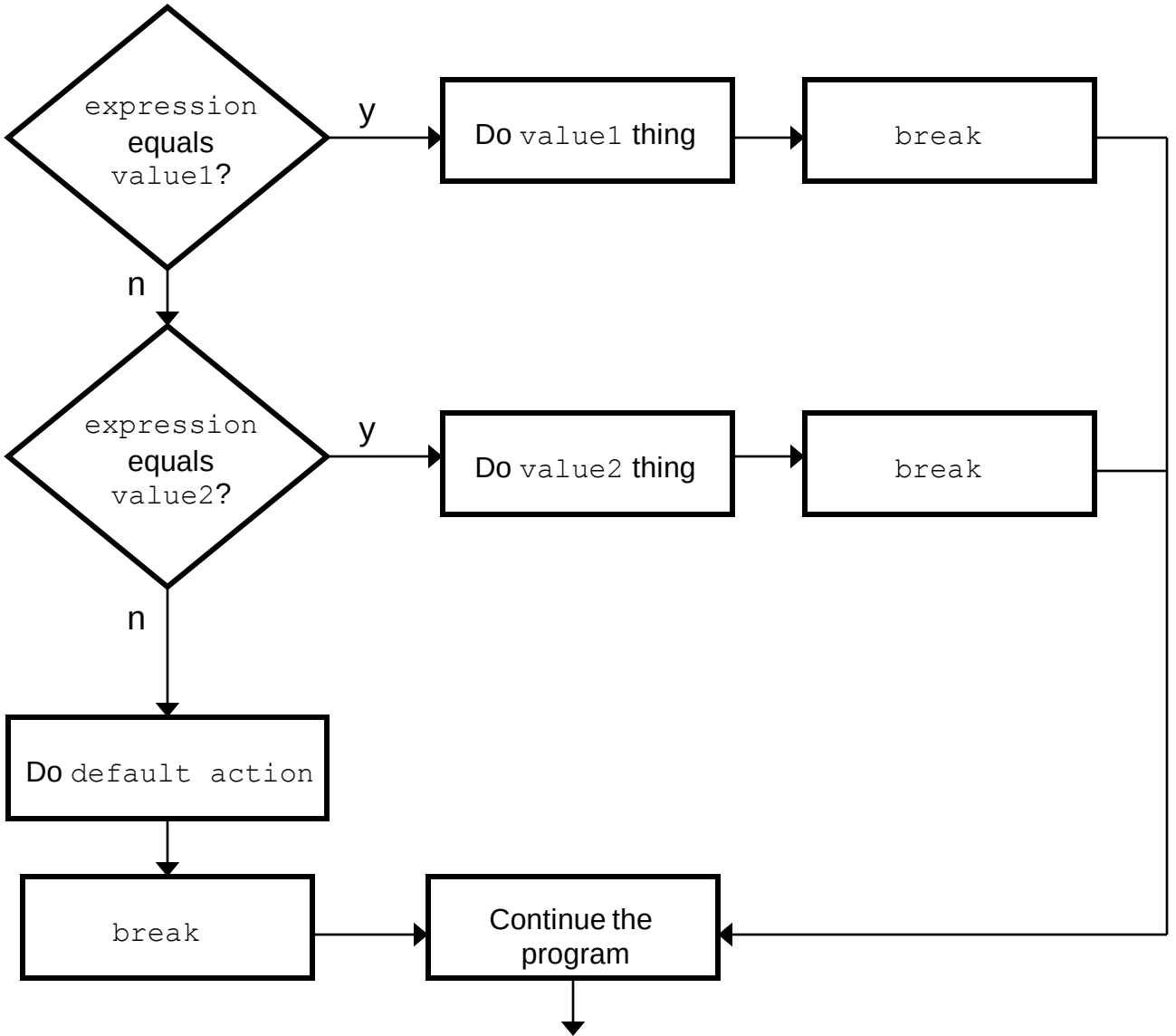
- The `break;` statement exits the switch statement

switch Statement Flow Chart

```
switch (expression){
    case value1:
      // Do value1 thing
      break;

    case value2:
      // Do value2 thing
      break;

    ...
    default:
      // Do default action
      break;
}
// Continue the program
```



Remember the Example…

- Here is the example of chained if-else statements:

```
if (grade == 'A')
 System.out.println("You got an A.");

else if (grade == 'B')
 System.out.println("You got a B.");

else if (grade == 'C')
 System.out.println("You got a C.");

else
 System.out.println("You got an F.");
```

Chained if-then-else as switch

- Here is the previous example as a switch

```
switch (grade) {
   case 'A':
      System.out.println("You got an A.");
      break;
   case 'B':
      System.out.println("You got a B.");
      break;
   case 'C':
      System.out.println("You got a C.");
      break;
   default:
      System.out.println("You got an F.");
}
```

What if there are no breaks?

- Without break, switch statements will execute the first statement for which the expression matches the case value AND then evaluate all other statements from that point on

- For example:

```
switch (expression) {

    case value1:
       statement1;

    case value2:
       statement2;

    default:
       default_statement;
}
```

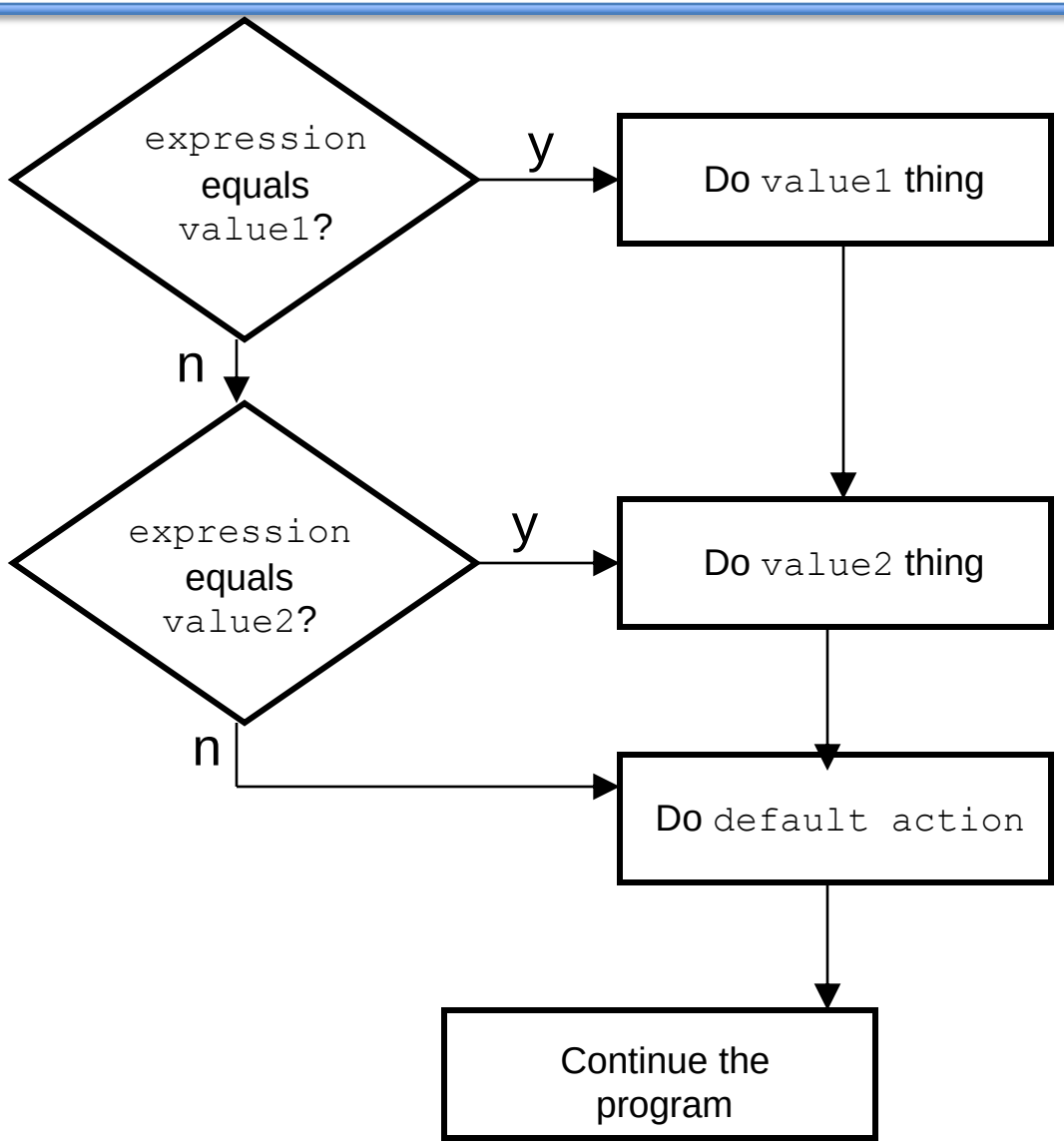
- NOTE: **Every statement after the true case is executed**

Switch Statement Flow Chart w/o breaks

```
switch (expression){
    case value1:
     // Do value1 thing

    case value2:
     // Do value2 thing

    ...
    default:
     // Do default action
}
// Continue the program
```



Loops

- A loop allows you to execute a statement or block of statements repeatedly.

- There are 4 types of loops in Java:
  1. `while` loops
  2. `do-while` loops
  3. `for` loops
  4. `foreach` loops (coming soon!)

The `while` Loop

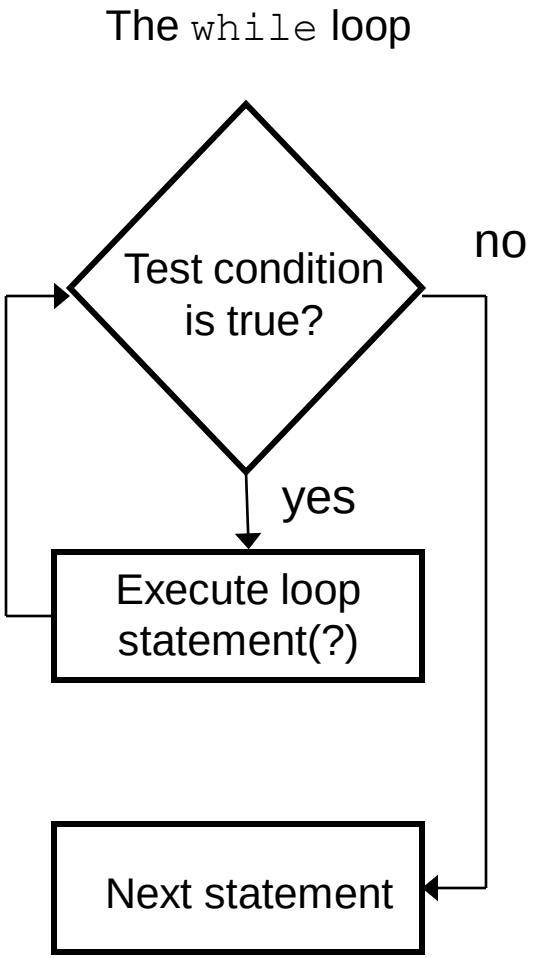
```
while (condition){
   statement
}
```

- This while loop executes as long as `condition` is `true`. When `condition` is `false`, execution continues with the statement following the loop block.

- The condition is tested at the beginning of the loop, so if it is initially `false`, the loop will not be executed at all.

`while` Loop Flow Chart

```
while (expression){
    statement
}
```



Example

```
int limit = 4;
int sum = 0;
int i = 1;

while (i < limit){
   sum += i;
        i++;
}
```

i = 1 sum = 1

i = 2 sum = 3

i = 3 sum = 6

i = 4

- What is the value of `sum` ?

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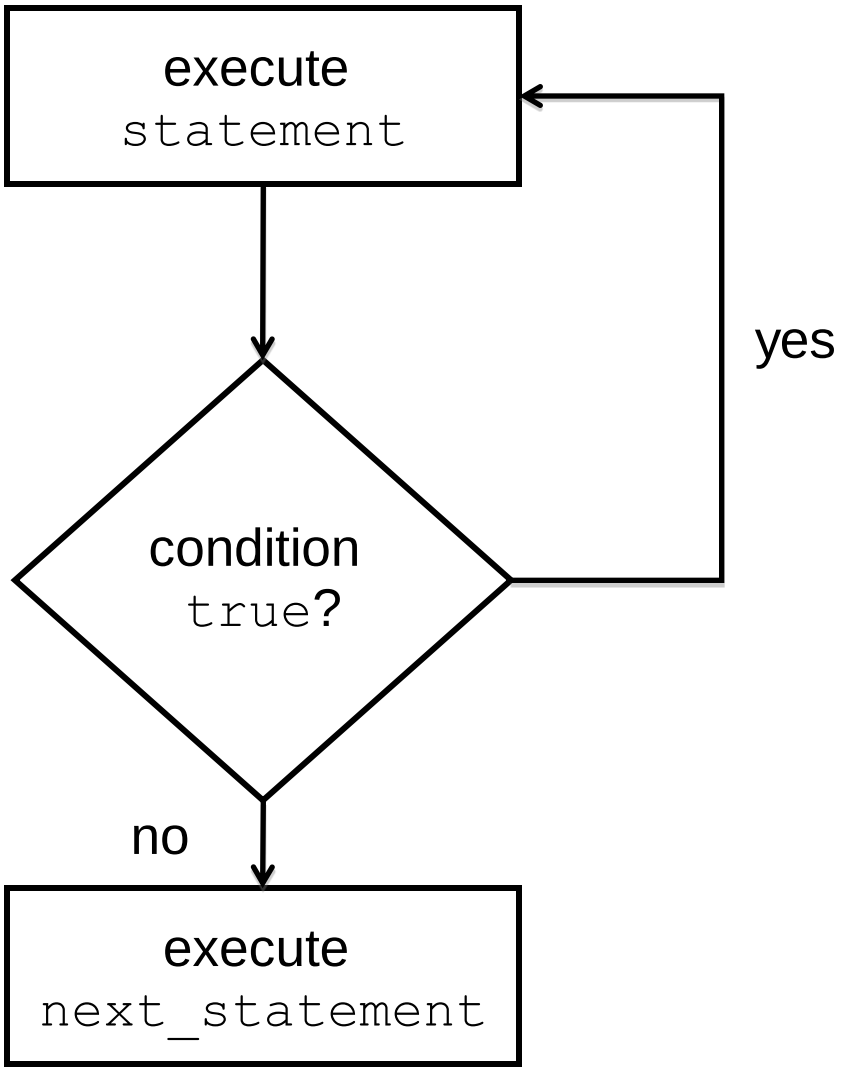
do-while Loops

- Similar to while loop but guarantees **at least one** execution of the body

```
do {
   statement;
}
while(condition
)
```

do-while Flowchart

```
do {
   statement;
}
while(condition)
next_statement;
```



do-while Example

```
boolean test = false;


do {
   System.out.println(“Hey!”)
}
while(test)
```

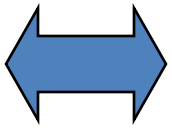
Output:

Hey!

for Loop

- Control structure for capturing the most common type of loop

```
i = start;
while (i <= end)
{
   . . .
   i++;
}
```



```
for (i = start; i <= end; i++)
{
     ...
}
```

Dissecting the for Loop

```
for (initialization; condition; update)
{
    statement;
}
```

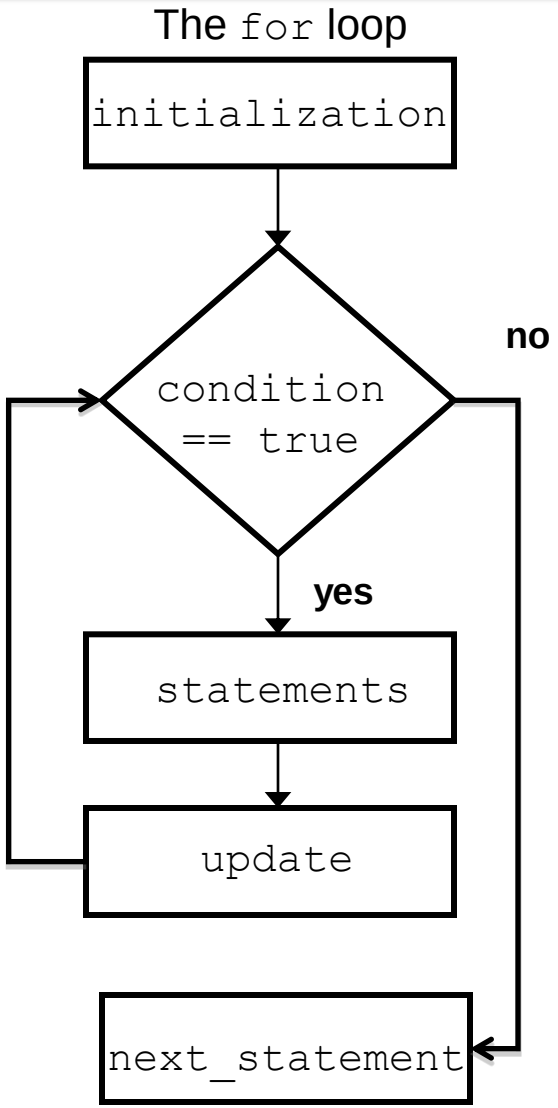
The control of the `for` loop appear in parentheses and is made up of three parts.

1. The first part, the `initialization`, sets the initial conditions for the loop and is executed before the loop starts.

2. Loop executes so long as the `condition` is true and exits otherwise

1. The third part of the control information, the `update`, is used to increment the loop counter. This is executed at the end of each loop iteration.

for Loop Flow Chart




```
for (initialization;
     condition;
     update)
{
    //statements
}
next_statement;
```

Example

```
int limit = 4;
int sum = 0;

for(int i = 1; i<=limit; i++ )
{
   sum += i;
}
```

i = 1	sum = 1
i = 2	sum = 3
i = 3	sum = 6
i = 4	sum = 10
i = 5	-- --

- What is the value of `sum` ?

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Another Example

```
for ( int div = 0; div<1000; div++ ) {

 if ( div % 12 == 0 ){

     System.out.println(div+"is divisible by 12");

 }
}
```

- This loop will display every number from 0 to 999 that is evenly divisible by 12.

Other Possibilities

- If there is more than one variable to set up or increment they are separated by a comma.

```
for (i=0, j=0; i*j<1000; i++, j+=2) {

    System.out.println(i+"*"+j+"="+i*j);

}
```

- You do not have to fill every part of the control of the `for` loop but you must still have two semi-colons.

```
for (int i=0; i<100; ) {

    sum+=i;
        i++;
}
```

*Straying far from convention may make code difficult to understand and thus is **not common**

Using the break Statement in Loops

- We have seen the use of the break statement in the switch statement.
- In loops, you can use the break statement to exit the current loop you are in. Here is an example:

```
int index = 0;
while (index <= 4) {
 index++;
 if (index == 3)
    break;
   System.out.println("The index is “
         + index);
}
```

index = 1

index = 2

index = 3

The index is 1

The index is 2

Using the continue Statement in Loops

- Continue statement causes the loop to jump to the next iteration
- Similar to break, but only skips to next iteration; doesn't exit loop completely

```
int index = 0;
while (index <= 4){
 index++;
 if (index == 3)
    continue;
   System.out.println("The index is "
       + index);
}
```

index = 1 The index is 1

index = 2 The index is 2

index = 3 -- --

Index = 4 The index is 4

Nested Loops – Example

- Printing a triangle

```
for (int i=1; i<=5; i++){
   for (int j=1; j<=i; j++){
     System.out.println("*");
   }
}
```

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

Control Structures Review Questions

You are withdrawing money from a savings account.

How do you use an If Statement to make sure you do not withdraw more than you have?

```
if ( amount < balance )
 {
    balance = balance – amount;
}
//next statement
```

Which Control Structure?

- As a programmer, you will never be asked something like: “Write a for loop to…”
- You will need to implement logic in your program that meets your specification and requirements
- With experience, you will know which control structure to use.