Introduction to Programming

Week – *4*, Lecture – *2*

Loops in C – `for`

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What we know so far…

In the `do-while` loop, the condition is put at the end, after the body of the loop

- This means that the loop will run at least once, even if the condition is false at the start of the loop

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- Statements that set initial values for variables that are important for the loop
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For `while` and `do-while` loops, there is no designated slot for these statements

The `for` loop in C (as well as C++ and Java), provide slots to provide these statements as well

- … in addition to the condition to stay in the loop

The `for` loop in C

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Statements before the loop
for(initialisation; condition; update)
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Initialisation statements are typical assignment statements of the form `x = y` (`y` could be a constant, a variable or an expression)

The `for` loop in C

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Statements after the loop
```

This is the condition to stay in the loop – similar to the condition in a `do-while` or `while` loop

The `for` loop in C

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for(initialisation; condition; update)
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Typically, we increment or decrement the variable(s) that we initialised in the initialisation slot (usually by a fixed amount, e.g. `1`)

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The flow moves through a `for` loop in a specific fashion

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After the statements before the loop get executed…

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Statements before the loop
for(initialisation; condition; update)
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Statements after the loop
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… the initialisation statements are executed

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Statements before the loop
for(initialisation; condition; update)
{
    Statements to execute in the loop
}
Statements after the loop
```

The flow moves through a `for` loop in a specific fashion

Then, the condition is checked; if it is false, the flow doesn't enter the loop… otherwise…

The `for` loop in C

```
Statements before the loop
for(initialisation; condition; update)
{
    Statements to execute in the loop
}
Statements after the loop
```

The flow moves through a `for` loop in a specific fashion

… the statements within the loop are executed

The `for` loop in C

```
Statements before the loop
for(initialisation; condition; update)
{
    Statements to execute in the loop
}
Statements after the loop
```

The flow moves through a `for` loop in a specific fashion

Then, the update statements are executed

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Statements before the loop
for(initialisation; condition; update)
{
    Statements to execute in the loop
}
Statements after the loop
```

The flow moves through a `for` loop in a specific fashion

Post-update, the condition is rechecked; if it is true, the control enters the loop again… otherwise…

The `for` loop in C

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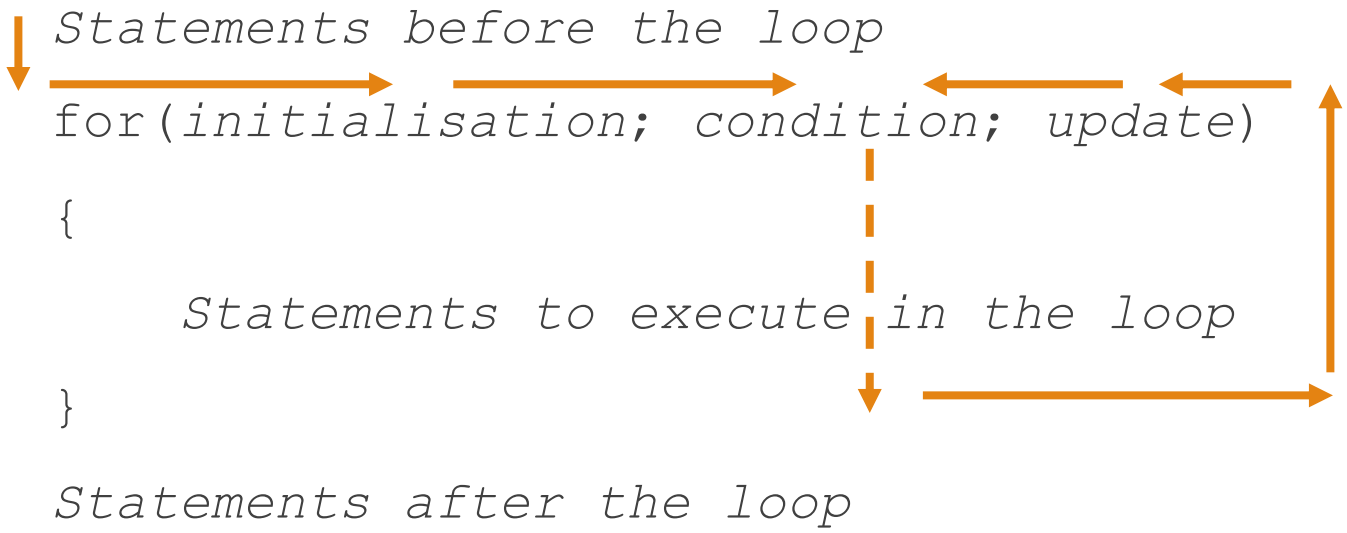
The flow moves through a `for` loop in a specific fashion

… the loop is terminated

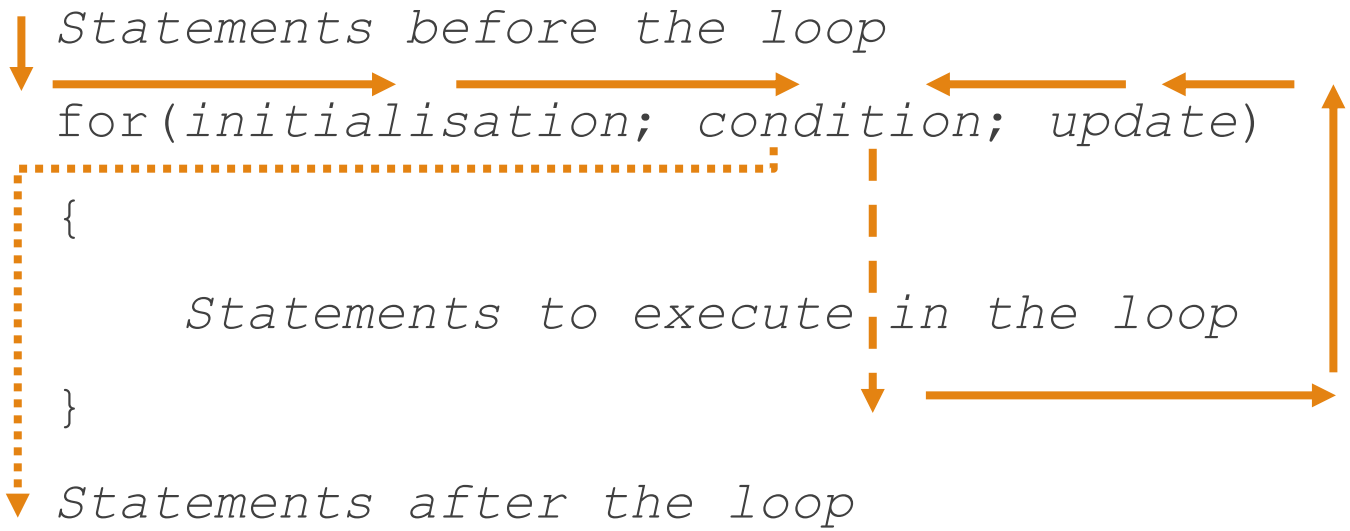
The `for` loop in C



The flow moves through a `for` loop in a specific fashion

When `condition` is true

The `for` loop in C



The flow moves through a `for` loop in a specific fashion

When `condition` is true

When `condition` is false

When to use `for` loop?

Similar to the `while` and `do-while` loop, the `for` loop too can be used for any scenario

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A common example, is to browse through the elements of an array

- … i.e. access each element of the array in order (so the loop should run ”size of the array” times)

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A common example, is to browse through the elements of an array

- … i.e. access each element of the array in order (so the loop should run ”size of the array” times)

Remember that Marks Calculator task? The `for` loop is a good choice there

Revisiting the Marks Summer

```c
#include<stdio.h>

int main()
{
        int total_marks, total_maximum_marks;
        int marks[5];
        int max[5];

        printf("Please provide marks for five subjects\n");
        printf("Enter the marks in the format obtained/maximum\n");
        printf("Example:\n");
        printf("90/100\n");

        scanf("%d/%d", &marks[0], &max[0]);
        scanf("%d/%d", &marks[1], &max[1]);
        scanf("%d/%d", &marks[2], &max[2]);
        scanf("%d/%d", &marks[3], &max[3]);
        scanf("%d/%d", &marks[4], &max[4]);

        total_marks = marks[0] + marks[1] + marks[2] + marks[3] + marks[4];
        total_maximum_marks = max[0] + max[1] + max[2] + max[3] + max[4];

        printf("Total obtained marks: %d\n", total_marks);

        printf("Total maximum marks: %d\n", total_maximum_marks);

        return 0;
}
```

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        total_maximum_marks = max[0] + max[1] + max[2] + max[3] + max[4];

        printf("Total obtained marks: %d\n", total_marks);

        printf("Total maximum marks: %d\n", total_maximum_marks);

        return 0;
}
```

Let us get back to this part of the code again…

These are all equivalent…

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scanf("%d/%d", &marks[0], &max[0]);
scanf("%d/%d", &marks[1], &max[1]);
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int i = 0;
scanf("%d/%d", &marks[i], &max[i]); i = i+1;
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for(int i = 0; i < 5; i++)
        scanf("%d/%d", &marks[i], &max[i]);
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for(int i = 0; i < 5; i++)
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Modern C compilers allow “creating” a variable, who’s “scope” is limited to the `for` loop

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Modern C compilers allow “creating” a variable, who’s “scope” is limited to the `for` loop

The scope of a variable, is the code block in which it is “visible”

Here, the variable `i` is only visible within the `for` loop, and not outside it

Also, if the `for` loop has a single statement in the loop’s body, the braces, i.e. the `{` and `}`, are optional

Some points about the `for` loop

The initialisation part of a `for` loop is executed “exactly once”

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All three parts of a `for` loop can be an *empty statement*

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- This means, that it is perfectly legal to write this:

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for(;;)
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    // body of the loop
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If the condition is not provided, by default it is *evaluated to true*

- So the above loop is basically an infinite loop, unless you find a mechanism to "break" out of it
- This mechanism is often used in programming to provide "loop exit conditions" in the "middle of the loop"
- We will see this mechanism in the next lecture

Another example – the same old Factorial

```c
#include<stdio.h>

int main()
{
        int num = -1, i;
        long result = 1;

        for(;num < 0;)
        {
                printf("Give me a small positive integer: ");
                scanf("%d", &num);
        }

        for(i = 2; i <= num; i++)
                result *= i;

        printf("Calculated Factorial: %ld\n", result);

        return 0;
}
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We are providing only the condition here, and not using the two other slots in the `for` loop

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        }

        for(i = 2; i <= num; i++)
                result *= i;

        printf("Calculated Factorial: %ld\n", result);

        return 0;
}
```

Here, we start the loop with an initial value of `2` for `i`, taking care of the factorial of `0` problem !!

Detour – The ++ operator

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The `++` operator is a very common *unary* operator used with the `for` loop

It has two avatars – the "*prefix* `++`" (e.g. `++i`) and the "*postfix* `++`" (e.g. `i++`)

- The *postfix* `++` can be interpreted as "use the value of the variable, then increment its value by 1"
- The *prefix* `++` can be interpreted as "increment the value of the variable by 1, then use it"

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They both have different precedence and *associativity*

- *postfix* `++` has a higher precedence than *prefix* `++`
- The associativity of *postfix* `++` is left to right (what we know so far), and that of *prefix* `++` is right to left

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- *postfix* `++` has a higher precedence than *prefix* `++`
- The associativity of *postfix* `++` is left to right (what we know so far), and that of *prefix* `++` is right to left

However, associativity is an issue, only when you have two operators with same precedence

- Let us leave the associativity doubts for later weeks; for now, just concentrate on their usage

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i++;
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If you do use it in an expression, this what it means:

- The *prefix* ++:

```
j = k * ++i - l;
```
is equivalent to
```
i = i + 1;
j = k * i - l;
```

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```
i++;
++i;
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If you do use it in an expression, this what it means:

- The *prefix* ++:
  `j = k * ++i - l;` is equivalent to `i = i + 1; j = k * i - l;`
- The *postfix* ++:
  `j = k * i++ - l;` is equivalent to `j = k * i - l; i = i + 1;`

Homework !!

Find out which other loop(s) provide you the liberty of not using braces…

- … when the loop's body consists of just one statement

Are there any other places where this – single statement code block without braces – is applicable?

- Find out !!

Go through the Operator Precedence Table again

- Find out where the *postfix* and *prefix* ++ operators lie on this table
- Using this table, convince yourself that we did not need to include them in parentheses in the example on the previous slide !!