Programming Fundamental

Week 11 –

Repetition controller structure in the C programming language

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Weekly Learning Outcomes for Subjects (Sub-CPMK):

Sub-CPMK 0614: Students are able to create simple programs with elements of selection control, repetition control, functions or procedures, and implement arrays and pointers in the C programming language (C6).

Review

1. IF…
2. Nested IF
3. Switch Case

Outline

1. For
2. While…
3. Do…While…
4. Break
5. Continue

Repetition Essentials

- A loop is a group of instructions the computer executes repeatedly while some loop repetition **condition** remains **true**

- 2 kinds of repetition
  - Counter-controlled repetition
  - Sentinel-controlled repetition

Counter-Controlled Repetition

- Counter-controlled repetition is sometimes called definite repetition because we know in advance exactly how many times the loop will be executed
- A loop control variable is used to count the number of repetitions
  - **Initialization :** Loop control variable is set to an initial value before the while statement is reached
  - **Testing :** Loop control variable is tested before the start of each loop repetition
  - **Updating :** Loop control variable is updated (incremented / decremented) during each iteration

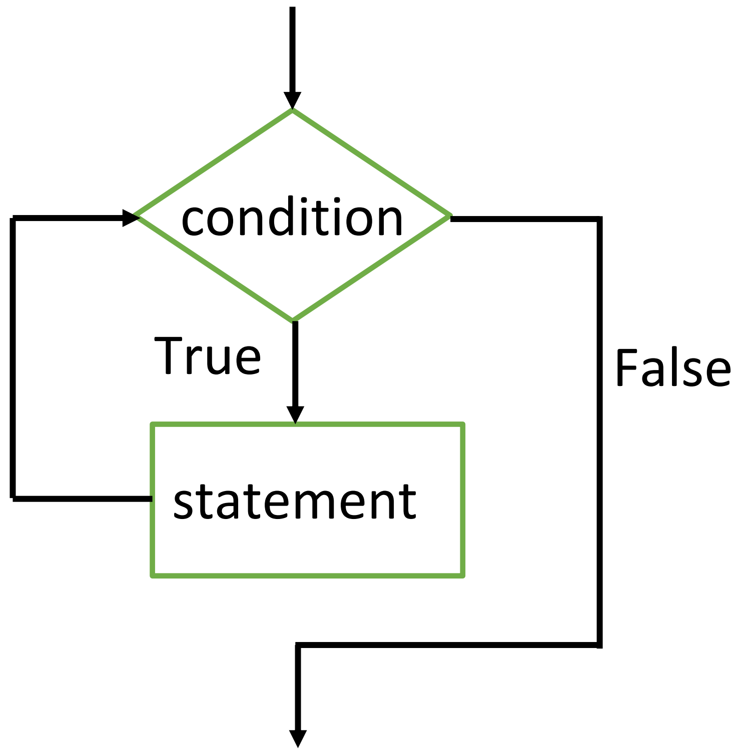
Sentinel-Controlled Repetition

- Sentinel-controlled repetition is sometimes called indefinite repetition because it’s not known in advance how many times the loop will be executed
- Sentinel values are used to control repetition when
  - The precise number of repetitions is not known in advance
  - The loop includes statements that obtain data each time the loop is performed
- The sentinel value indicates “end of data”
- The sentinel is entered after all regular data items have been supplied to the program
- Sentinels must be distinct from regular data items

While Statement

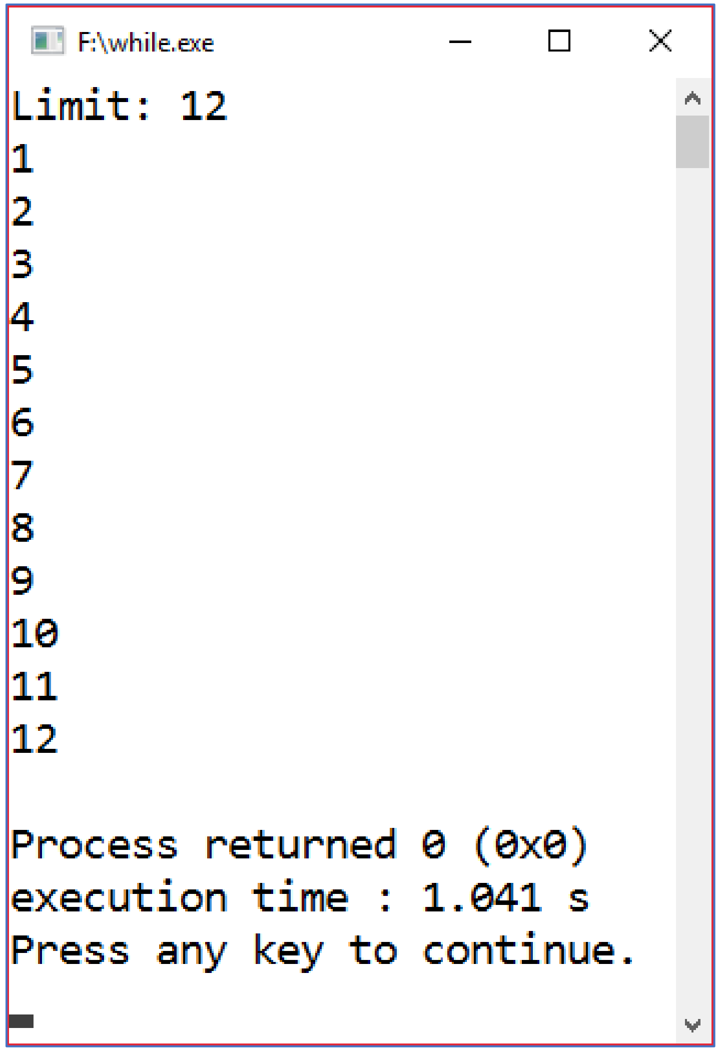
```
while(loop_repetition_condition)
{
      statement;
}
```

- The loop is repeated when the condition is true (when its value is not 0)
- The loop is exited when the condition is false

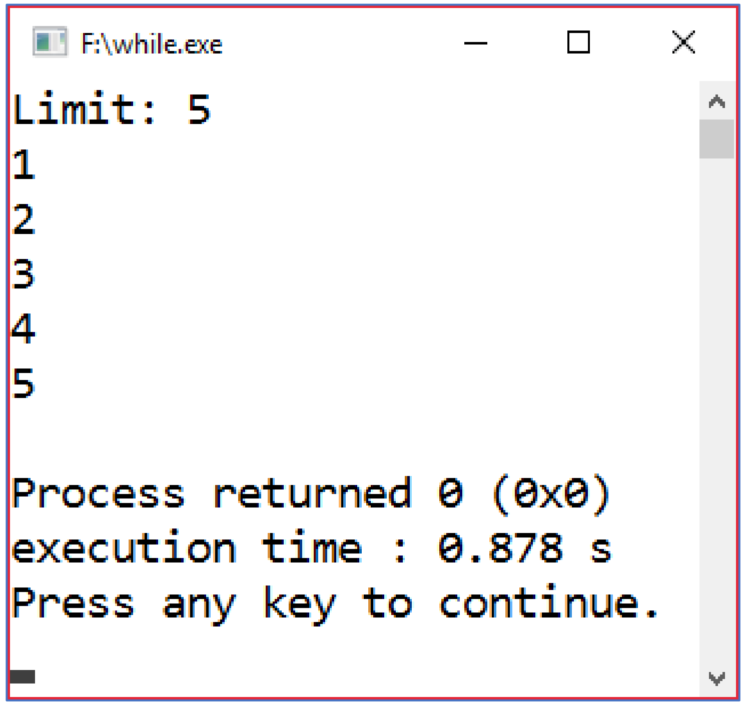


While Statement

```c
#include <stdio.h>

int main()
{
    int iCounter, iLimit;

    printf("Limit: ");
    scanf("%d",&iLimit);

    iCounter = 1;
    while(iCounter <= iLimit)
    {
        printf("%d\n",iCounter);
        iCounter++;
    }

    return 0;
}
```



```
Limit: 12
1
2
3
4
5
6
7
8
9
10
11
12

Process returned 0 (0x0)
execution time : 1.041 s
Press any key to continue.
```

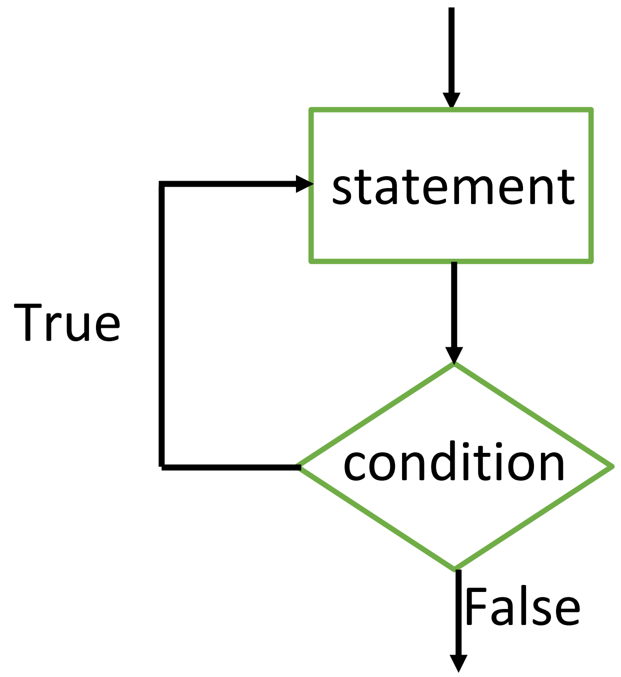


```
Limit: 5
1
2
3
4
5

Process returned 0 (0x0)
execution time : 0.878 s
Press any key to continue.
```

Do...While Statement

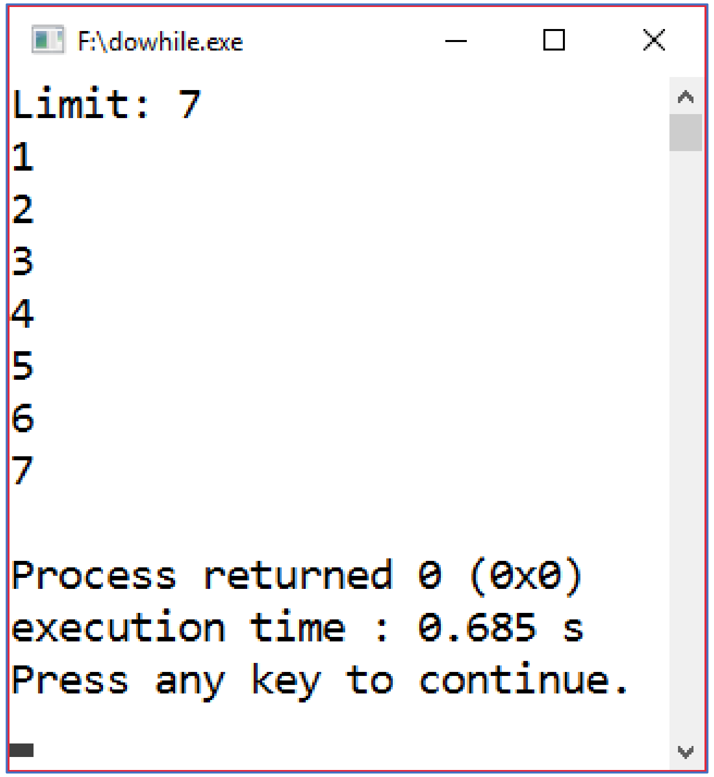
```
do
{
      statement;
}while(loop_repetition_condition);
```

- The do...while statement is similar to the while statement
- In the **while statement**, the loop repetition condition is tested at the beginning of the loop **before** the body of the loop is performed
- The **do...while statement** tests the loop repetition condition **after** the loop body is performed
- Therefore, the loop body will be executed **at least once**



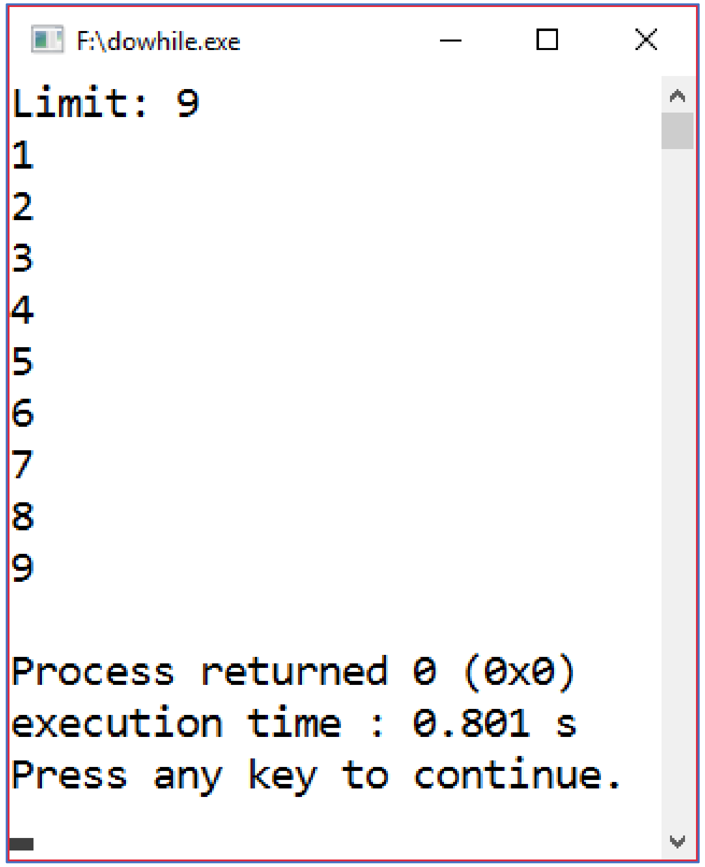
Do...While Statement

```c
#include <stdio.h>

int main()
{
    int iCounter, iLimit;

    printf("Limit: ");
    scanf("%d",&iLimit);

    iCounter = 1;
    do
    {
        printf("%d\n",iCounter);
        iCounter++;
    }while(iCounter <= iLimit);

    return 0;
}
```



F:\dowhile.exe

```
Limit: 7
1
2
3
4
5
6
7

Process returned 0 (0x0)
execution time : 0.685 s
Press any key to continue.
```

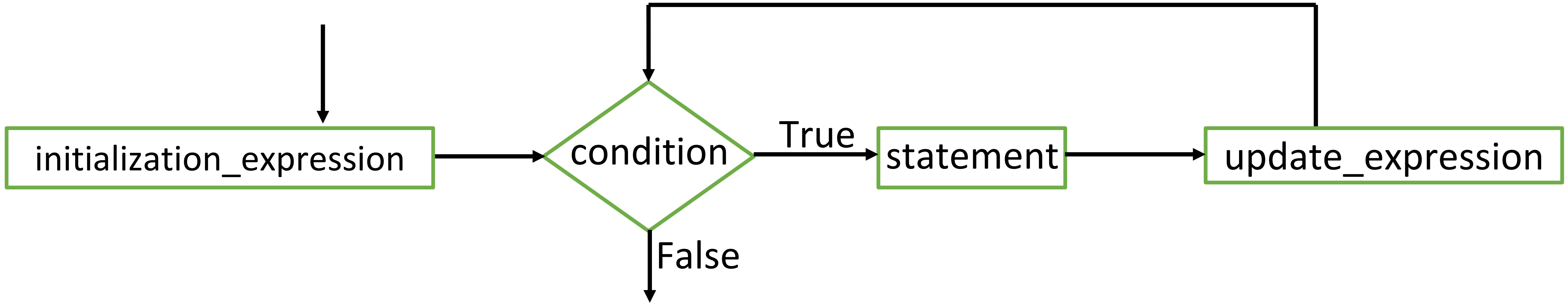


F:\dowhile.exe

```
Limit: 9
1
2
3
4
5
6
7
8
9

Process returned 0 (0x0)
execution time : 0.801 s
Press any key to continue.
```

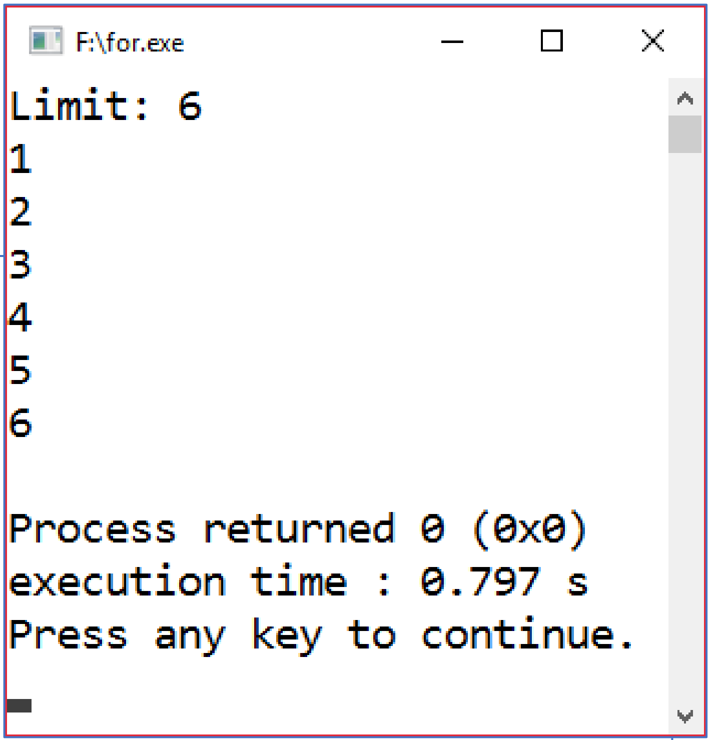
For Statement

```
for(initialization_expression;loop_repetition_condition;update_expression)
{
      statement;
}
```



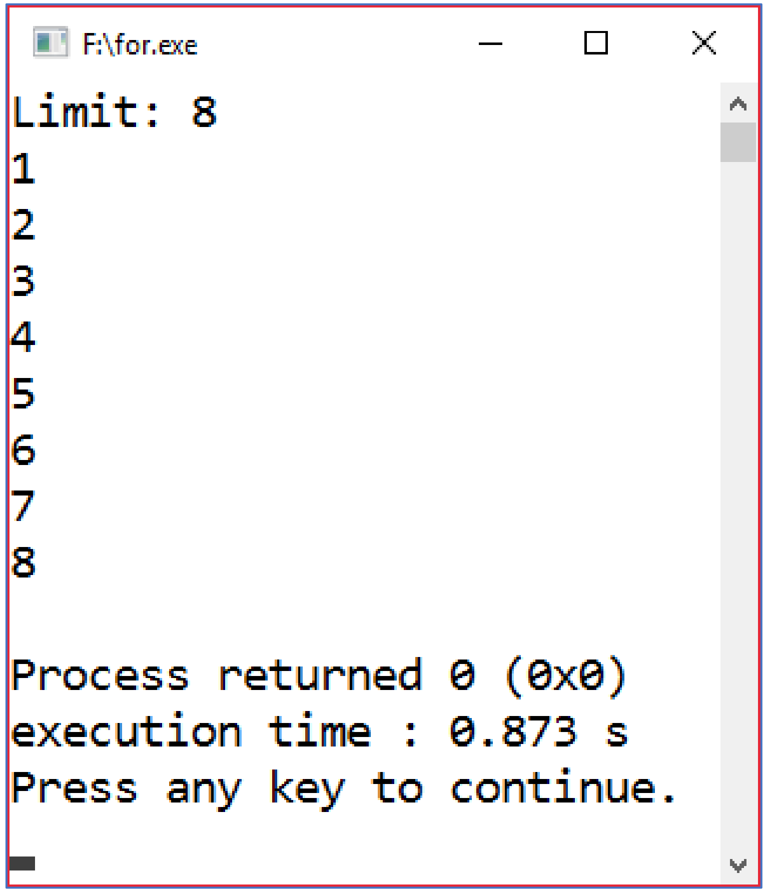
For Statement

```c
#include <stdio.h>

int main()
{
    int iCounter, iLimit;

    printf("Limit: ");
    scanf("%d",&iLimit);

    for(iCounter = 1;iCounter <= iLimit;iCounter++)
    {
        printf("%d\n",iCounter);
    }

    return 0;
}
```



F:\for.exe

```
Limit: 6
1
2
3
4
5
6

Process returned 0 (0x0)
execution time : 0.797 s
Press any key to continue.
```



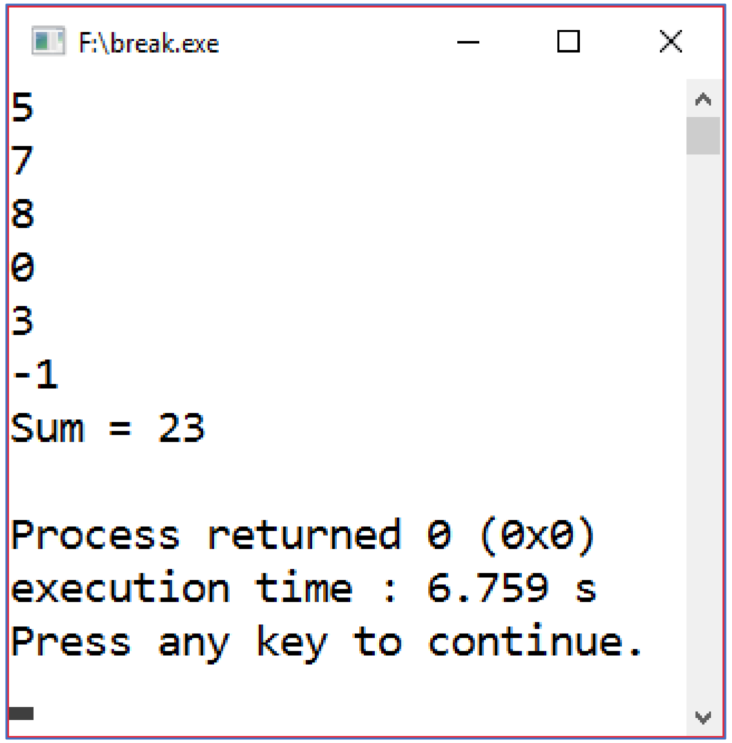
F:\for.exe

```
Limit: 8
1
2
3
4
5
6
7
8

Process returned 0 (0x0)
execution time : 0.873 s
Press any key to continue.
```

Break Statement

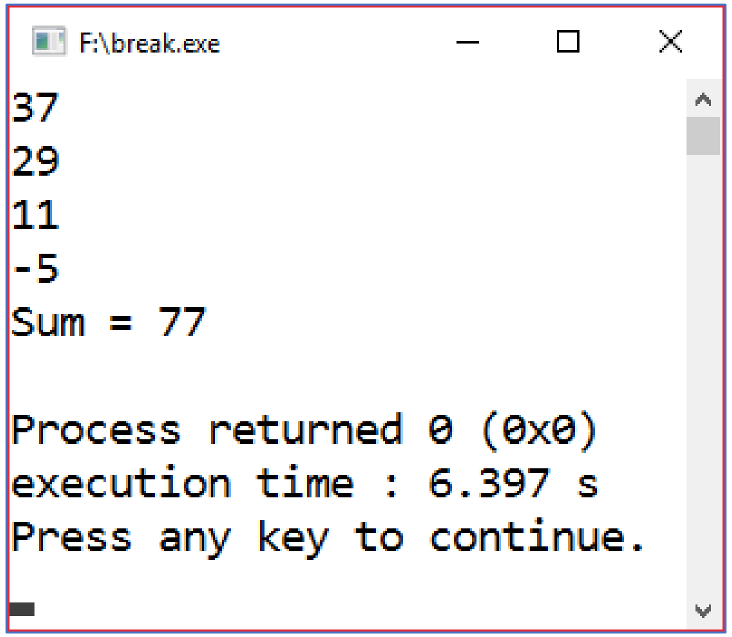
- The break statement, when executed in a **while**, **do…while**, **for**, or **switch** statement, causes an **immediate exit** from the statement

```c
#include <stdio.h>

int main()
{
    int iSum = 0, iNumber;

    while(1)
    {
        scanf("%d",&iNumber);
        if(iNumber < 0) break;
        iSum += iNumber;
    }
    printf("Sum = %d\n",iSum);

    return 0;
}
```



F:\break.exe

```
5
7
8
0
3
-1
Sum = 23

Process returned 0 (0x0)
execution time : 6.759 s
Press any key to continue.
```

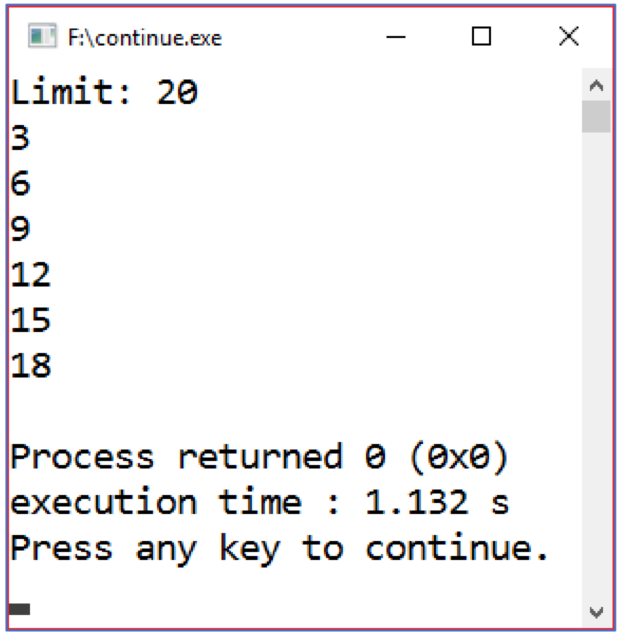


F:\break.exe

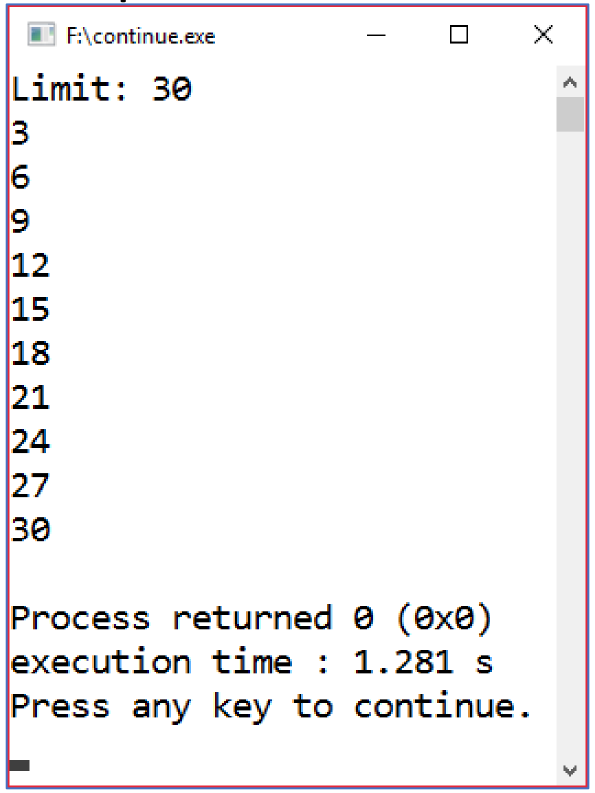
```
37
29
11
-5
Sum = 77

Process returned 0 (0x0)
execution time : 6.397 s
Press any key to continue.
```

Continue Statement

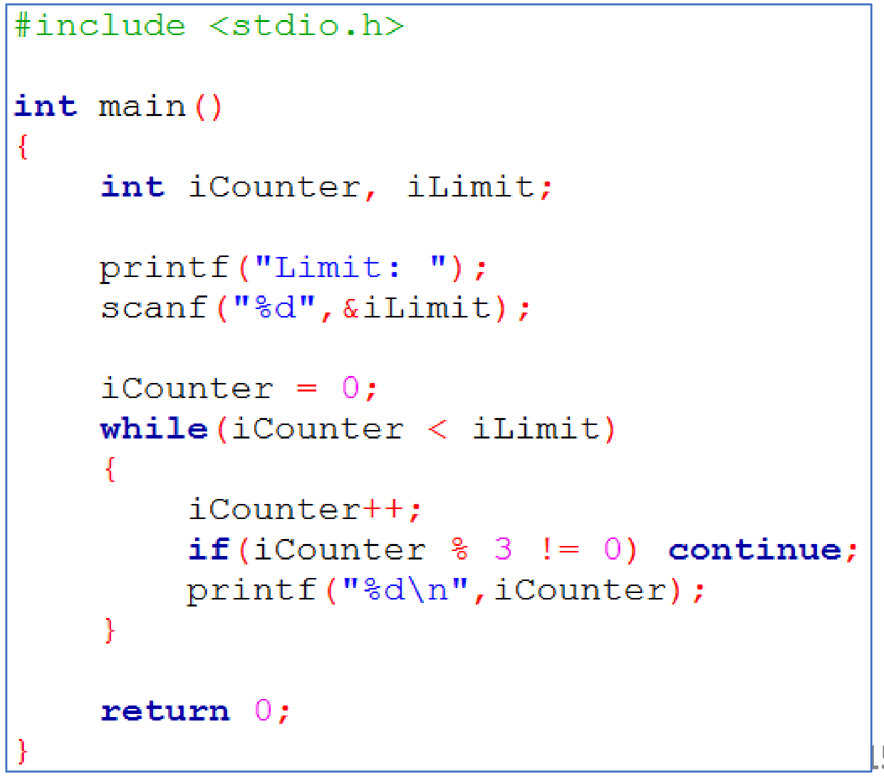
- The **continue** statement, when executed in a **while**, **do...while**, or **for** statement, **skips** the remaining statements in the body of that control statement and **performs the next iteration** of the loop
- In **while** and **do...while** statements, the loop repetition condition is evaluated immediately after the continue statement is executed
- In the **for** statement, the update expression is executed, then the loop repetition condition is evaluated



```
F:\continue.exe
Limit: 20
3
6
9
12
15
18

Process returned 0 (0x0)
execution time : 1.132 s
Press any key to continue.
```



```
F:\continue.exe
Limit: 30
3
6
9
12
15
18
21
24
27
30

Process returned 0 (0x0)
execution time : 1.281 s
Press any key to continue.
```

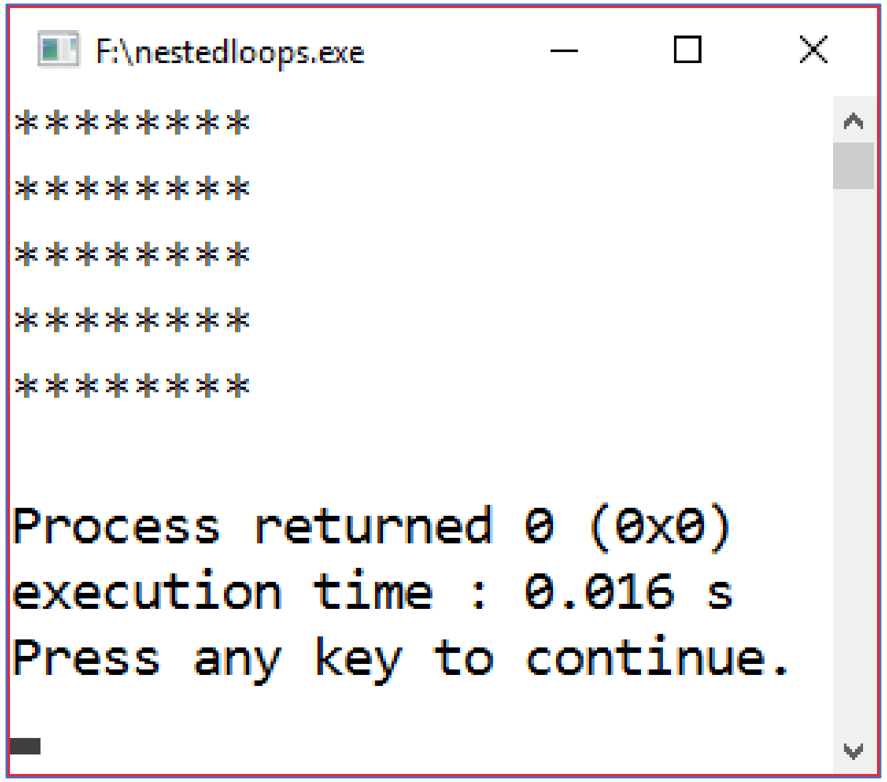


```
#include <stdio.h>

int main()
{
    int iCounter, iLimit;

    printf("Limit: ");
    scanf("%d",&iLimit);

    iCounter = 0;
    while(iCounter < iLimit)
    {
        iCounter++;
        if(iCounter % 3 != 0) continue;
        printf("%d\n",iCounter);
    }

    return 0;
}
```

Nested Loops

- Nested loops consist of an outer loop with one or more inner loops
- Each time the outer loop is repeated, the inner loops are reentered, their loop control expressions are reevaluated, and all required iterations are performed

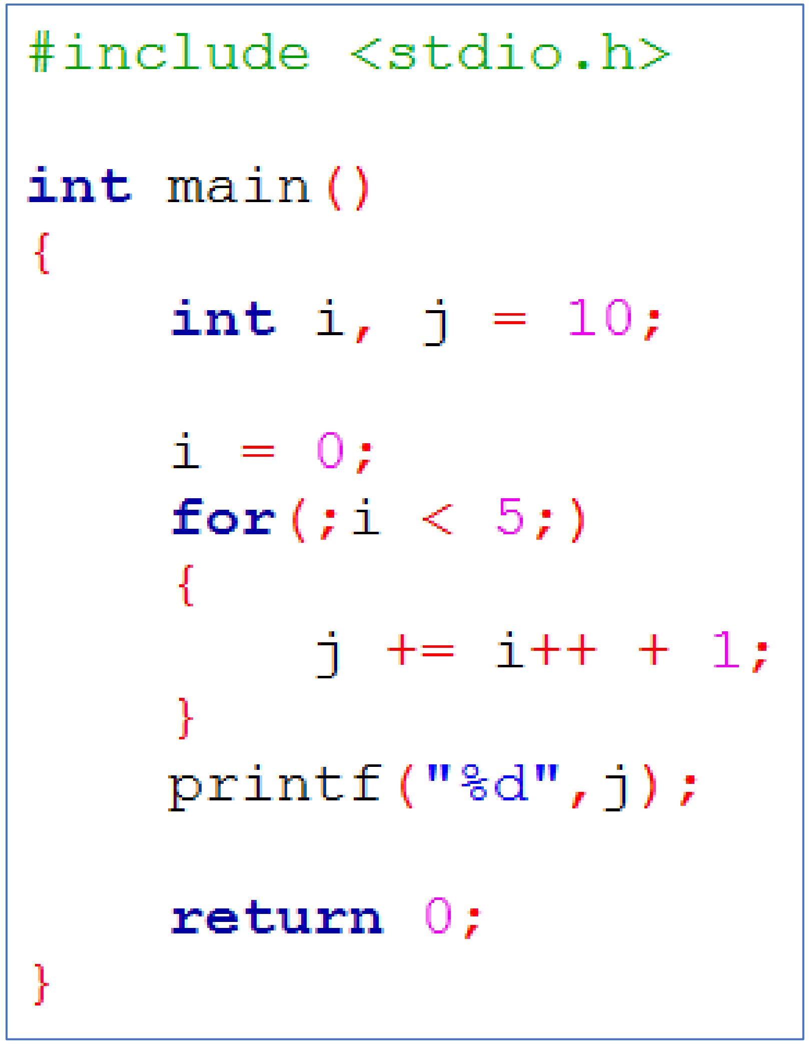
```c
#include <stdio.h>

int main()
{
    int iRow, iColumn;

    for(iRow = 0;iRow < 5;iRow++)
    {
        for(iColumn = 0;iColumn < 8;iColumn++)
        {
            printf("*");
        }
        printf("\n");
    }

    return 0;
}
```


F:\nestedloops.exe

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


Process returned 0 (0x0)
execution time : 0.016 s
Press any key to continue.
```

Practice 1

- What does the following code print?



```
#include <stdio.h>

int main()
{
    int i, j = 10;

    i = 0;
    for(;i < 5;)
    {
        j += i++ + 1;
    }
    printf("%d",j);

    return 0;
}
```

Practice 2

- What does the following code print?

```
#include <stdio.h>

int main()
{
    int i, j = 0;

    i = 10;
    while(1)
    {
        i--;
        if(i == 0) break;
        if(i % 2 == 0) continue;
        j += i;
    }
    printf("%d",j);

    return 0;
}
```

Practice 3

- What does the following code print?

```
#include <stdio.h>

int main()
{
    int i, j;

    for(i = 0;i < 3;i++)
    {
        for(j = 0;j < 5;j++)
        {
            printf("%3d",5*i+j+1);
        }
        printf("\n");
    }

    return 0;
}
```

Practice 4

- Write **for** statements that print the following sequence of values.

```
20 14 8 2 -4 -10
```

Practice 5

- Write **while** statements that print the following sequence of values.

```
19 27 34 40 45
```

Practice 6

- The factorial function is used frequently in probability problems. The factorial of a positive integer ***n*** (written ***n*!** and pronounced "*n* factorial") is equal to the product of the positive integers from 1 to ***n***. Write a program that evaluates the factorials of the integers from ***p*** to ***q*** (***p*** and ***q*** are inputted by user). The screen dialogue should appear as follows:

```
1 5
1! = 1
2! = 2
3! = 6
4! = 24
5! = 120
```

```
3 8
3! = 6
4! = 24
5! = 120
6! = 720
7! = 5040
8! = 40320
```

Practice 7

- Write a program that prints the following pattern. Use for loops to generate the pattern. All asterisks (*) should be printed by a single printf statement of the form **printf("*");**. The screen dialogue should appear as follows:

```
3
***
* *
***
```

```
4
****
*  *
*  *
****
```

```
5
*****
*   *
*   *
*   *
*****
```

```
7
*******
*     *
*     *
*     *
*     *
*     *
*******
```

NEXT WEEK’S OUTLINE

1. Modular Programming
2. Function Prototype
3. Function invocation (void)
4. Variable scope
5. Recursion

REFERENCES

- Hanly, Jeri R. and Koffman, Elliot B., 2013, Problem Solving and Program Design in C, Seventh Edition, Pearson Education, Inc.
- Deitel, Paul and Deitel, Harvey, 2016, C How to Program, Eighth Edition, Pearson Education, Inc.

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