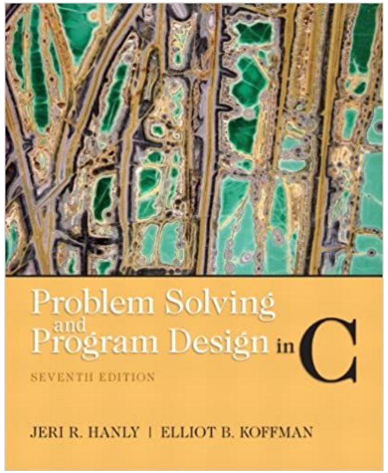
BIRZEIT UNIVERSITY

Faculty of Engineering and Technology
Department of Computer Science

Introduction to Computers and Programming (Comp 133)


Problem Solving and Program Design in C
SEVENTH EDITION
JERI R. HANLY | ELLIOT B. KOFFMAN

References :
Book : Problem Solving and Program Design in C (7th Edition) 7th Edition
Slides : Dr. Radi Jarrar , Dr. Abdallah Karakra , Dr. Majdi Mafarja.

Repetition and Loop Statements

Chapter 5

Repetition and Loop

- **loop** a control structure that repeats a group of steps in a program.
- There are 3 types of loops in C
  - **while**
  - **for**
  - **do-while**

Chapter 5

- Repetition in Programs

Loop Kinds

Kind	When Used	C Implementation Structures
Counting loop	We can determine before loop execution exactly how many loop repetitions will be needed to solve the problem.	`while` `for`
Sentinel-controlled loop	Input of a list of data of any length ended by a special value	`while, for`
Endfile-controlled loop	Input of a single list of data of any length from a data file	`while, for`
Input validation loop	Repeated interactive input of a data value until a value within the valid range is entered	`do-while`
General conditional loop	Repeated processing of data until a desired condition is met	`while, for`

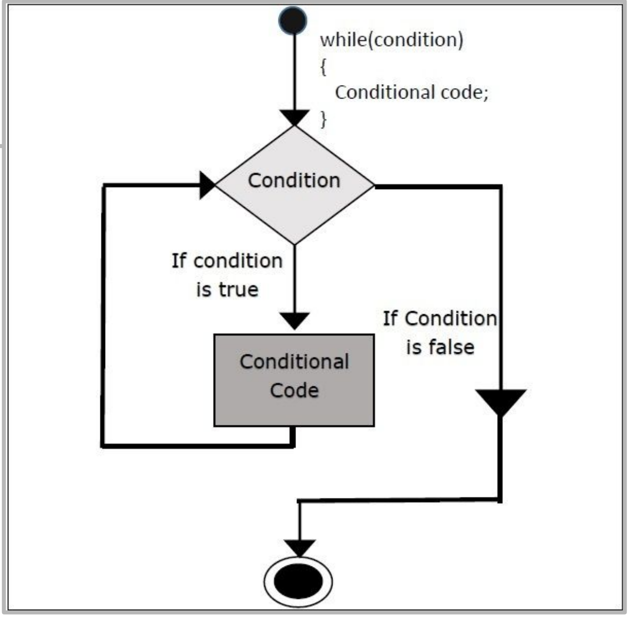
Controlling Loop

- **loop repetition condition:** the condition that controls loop repetition.
  - While(**count<10**)
- **Counter-controlled loop** : a loop whose required number of iterations can be determined before loop execution begins.
  - For(i=0;i<10;i++)
- **Event controlled loops:** stop when special value is encountered. (E.g., exit loop when input value is “E” , or stop a loop when input is -1).
  - While(X != -1)
- **Result controlled loops:** continues until a test determines that the desired result is reached (e.g., numerical approximations)
- **infinite loop** a loop that executes forever

While Loop

```
Set loop control variable to an initial value of 0 .
while loop control variable < final value
{
 Loop Body
 . . .
 Increase loop control variable by 1 .
}
```

```
count_star = 0;
n= 10;
while (count_star < n)
 {
   printf("*");
   count_star++;
 }
```



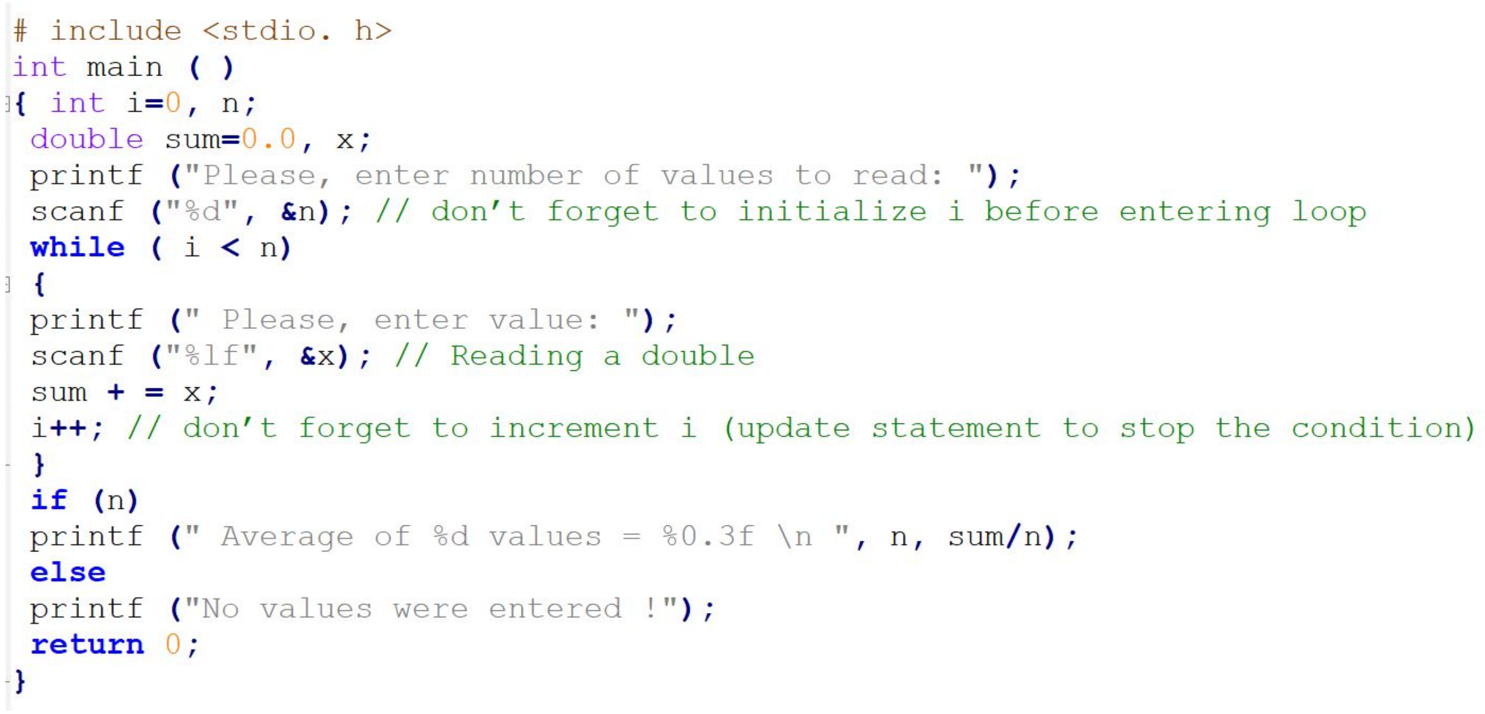
While Loop Example

- Write a program to print the first 100 positive integers.

```
#include<stdio.h>
int main(){
  int counter = 1;
  while( counter <= 100){
    printf(“%d\n”, counter);
    counter = counter + 1; //don’t forget
  }
  return 0;
}
```

While Loop Example

- Write a program to find and print the average of **n** values, where **n** is entered by the user.



```
# include <stdio. h>
int main ( )
{ int i=0, n;
 double sum=0.0, x;
 printf ("Please, enter number of values to read: ");
 scanf ("%d", &n); // don't forget to initialize i before entering loop
 while ( i < n)
 {
 printf (" Please, enter value: ");
 scanf ("%lf", &x); // Reading a double
 sum + = x;
 i++; // don't forget to increment i (update statement to stop the condition)
 }
 if (n)
 printf (" Average of %d values = %0.3f \n ", n, sum/n);
 else
 printf ("No values were entered !");
 return 0;
}
```

While Loop Example

Write a program that reads 10 grades and compute their average.

```
int main(){
  int counter = 0, grade, total = 0;
  float average;
  while( counter < 10 ){
    printf("Please enter a grade");
    scanf("%d", &grade);
    total = total + grade;
    counter = counter + 1;
  }
  average = total / counter;
  printf("The average is %f\n", average);
  return 0;
}
```

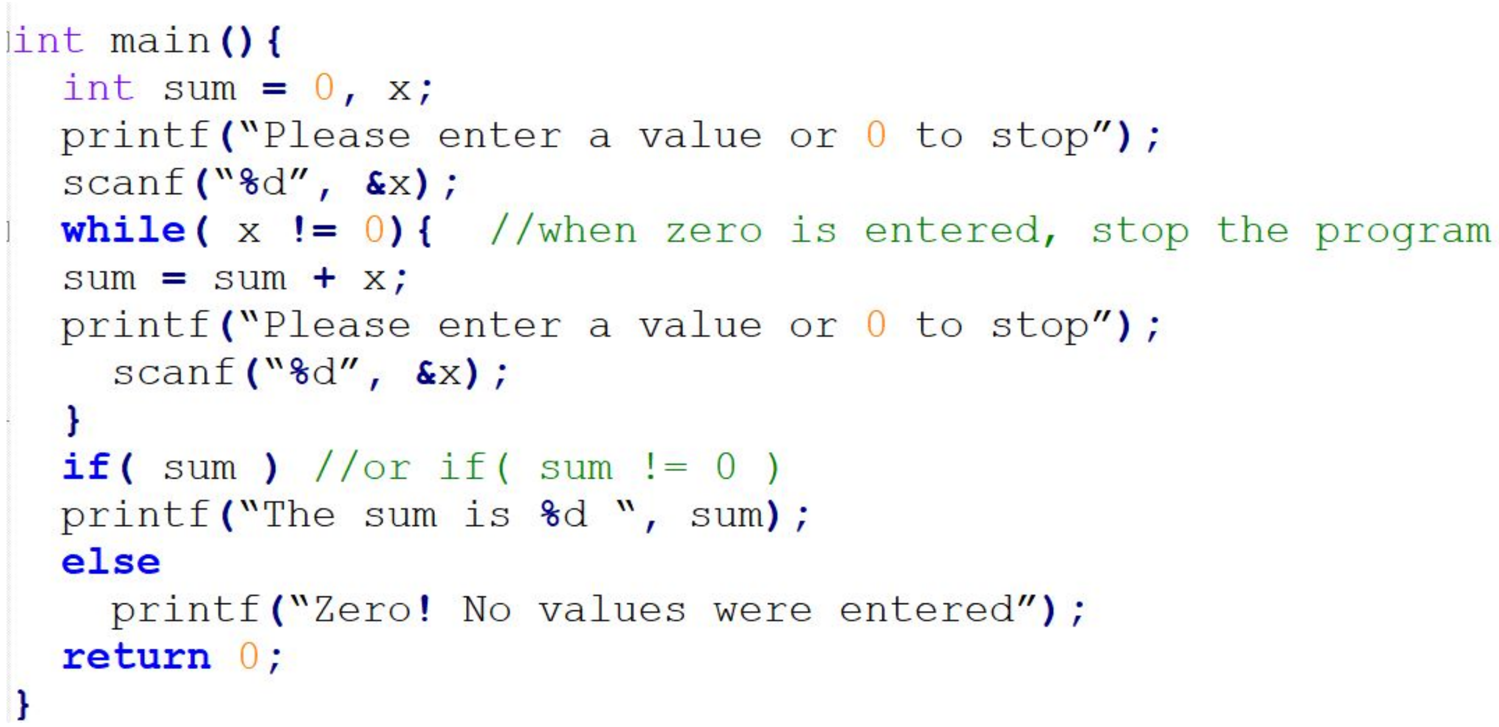
While Loop Example

Write a program that reads **n** grades and compute their average. When -1 is entered, stop.

```
int main(){
  int counter = 0, grade, total = 0;
  float average;
  printf("Please enter a grade");
  scanf("%d", &grade);
  while( grade != -1){
    total = total + grade;
    counter = counter + 1;

    printf("Please enter a grade");
  scanf("%d", &grade);
  }
  average = total / counter;
  printf("The average is %f\n", average);
  return 0;
}
```

While Loop Example

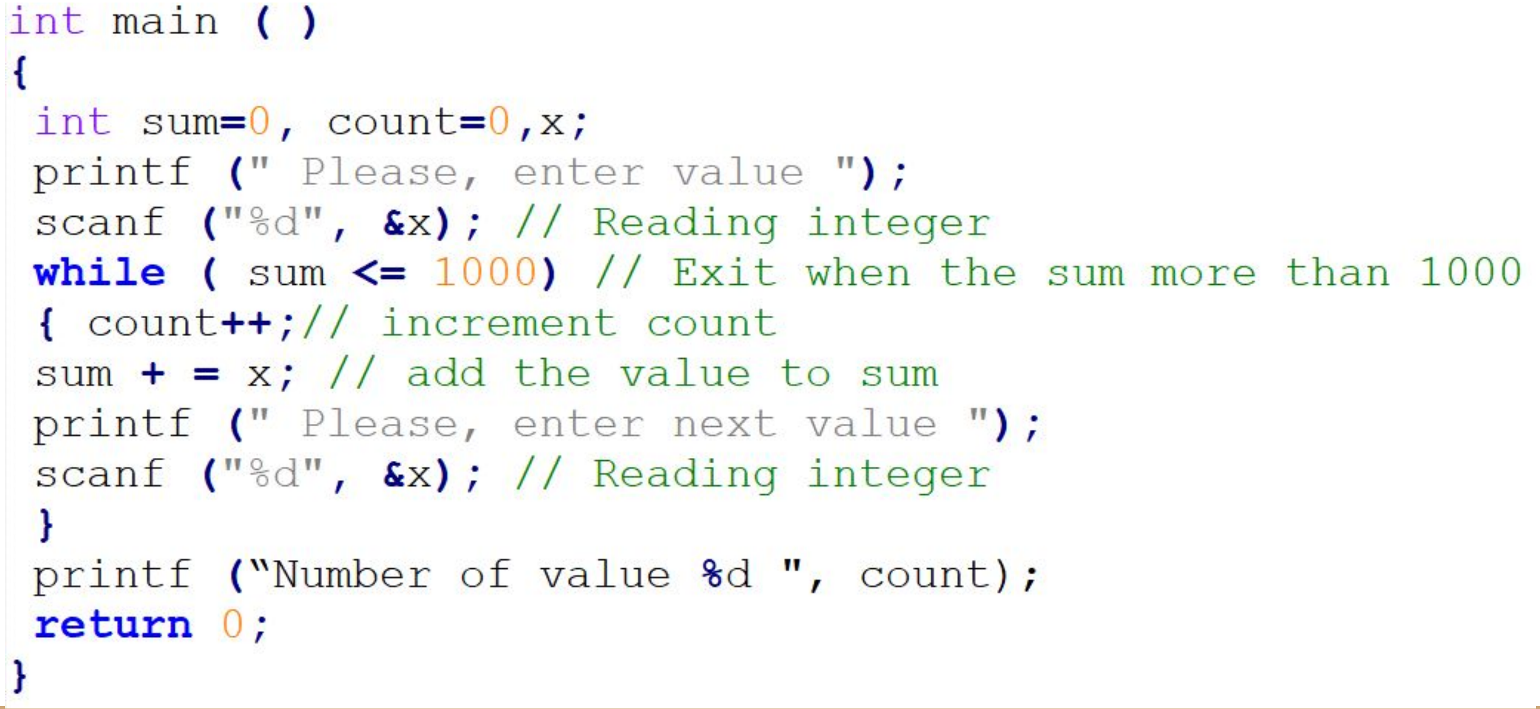
Write a program to calculate the sum of a set of values (we don’t know their count). When 0 is entered this means that program should stop receiving data, and print the sum.



```
int main(){
  int sum = 0, x;
  printf(“Please enter a value or 0 to stop”);
  scanf(“%d”, &x);
  while( x != 0){  //when zero is entered, stop the program
  sum = sum + x;
  printf(“Please enter a value or 0 to stop”);
    scanf(“%d”, &x);
  }
  if( sum ) //or if( sum != 0 )
  printf(“The sum is %d ", sum);
  else
    printf(“Zero! No values were entered”);
  return 0;
}
```

While Loop Example

Write a program to calculate the sum of a set of values (we don’t know their count). When the sum exceeds 1000 this means that program should stop receiving data, and print the number of values were entered.



```
int main ( )
{
 int sum=0, count=0,x;
 printf (" Please, enter value ");
 scanf ("%d", &x); // Reading integer
 while ( sum <= 1000) // Exit when the sum more than 1000
 { count++;// increment count
 sum + = x; // add the value to sum
 printf (" Please, enter next value ");
 scanf ("%d", &x); // Reading integer
 }
 printf (“Number of value %d ", count);
 return 0;
}
```

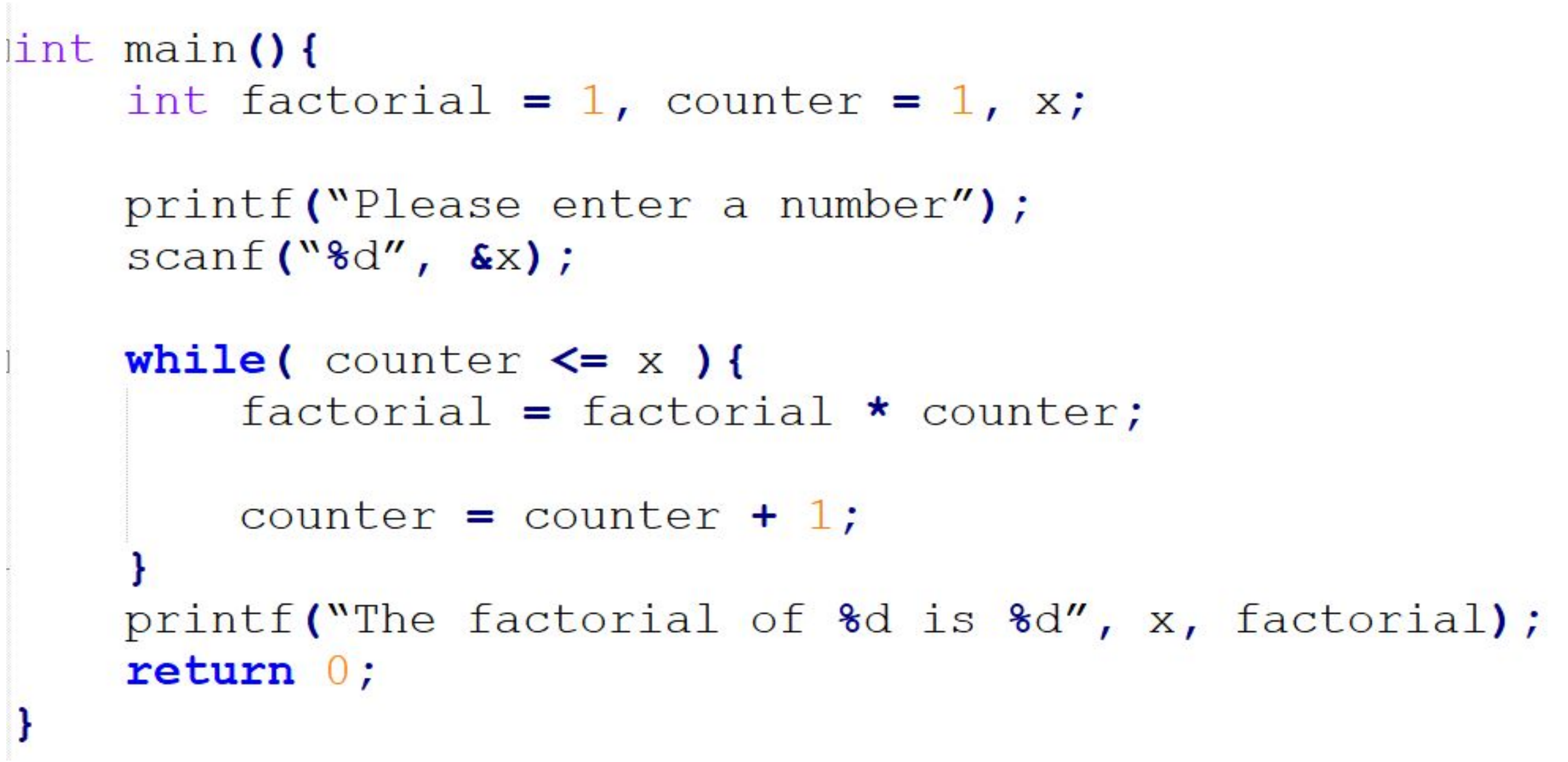
While Loop Example

Write a program to print the number of passes and the number of failures in a set of n students. The user should enter -1 to stop.

```
int main(){
    int countPasses = 0, countFails;
    int x;

    printf(“Please enter a value or -1 to stop”);
    scanf(“%d”, &x);

    while( x != -1){      //when -1 is entered, stop the program
        if( x >= 60)
            countPasses = countPasses + 1;
        else
            countFails = countFails + 1;
        printf(“Please enter a value or -1 to stop”);
        scanf(“%d”, &x);
    }
    printf(“Number of passes is %d and number of failures is %d”,countPasses, countFails);
    return 0;
}
```

While Loop Example

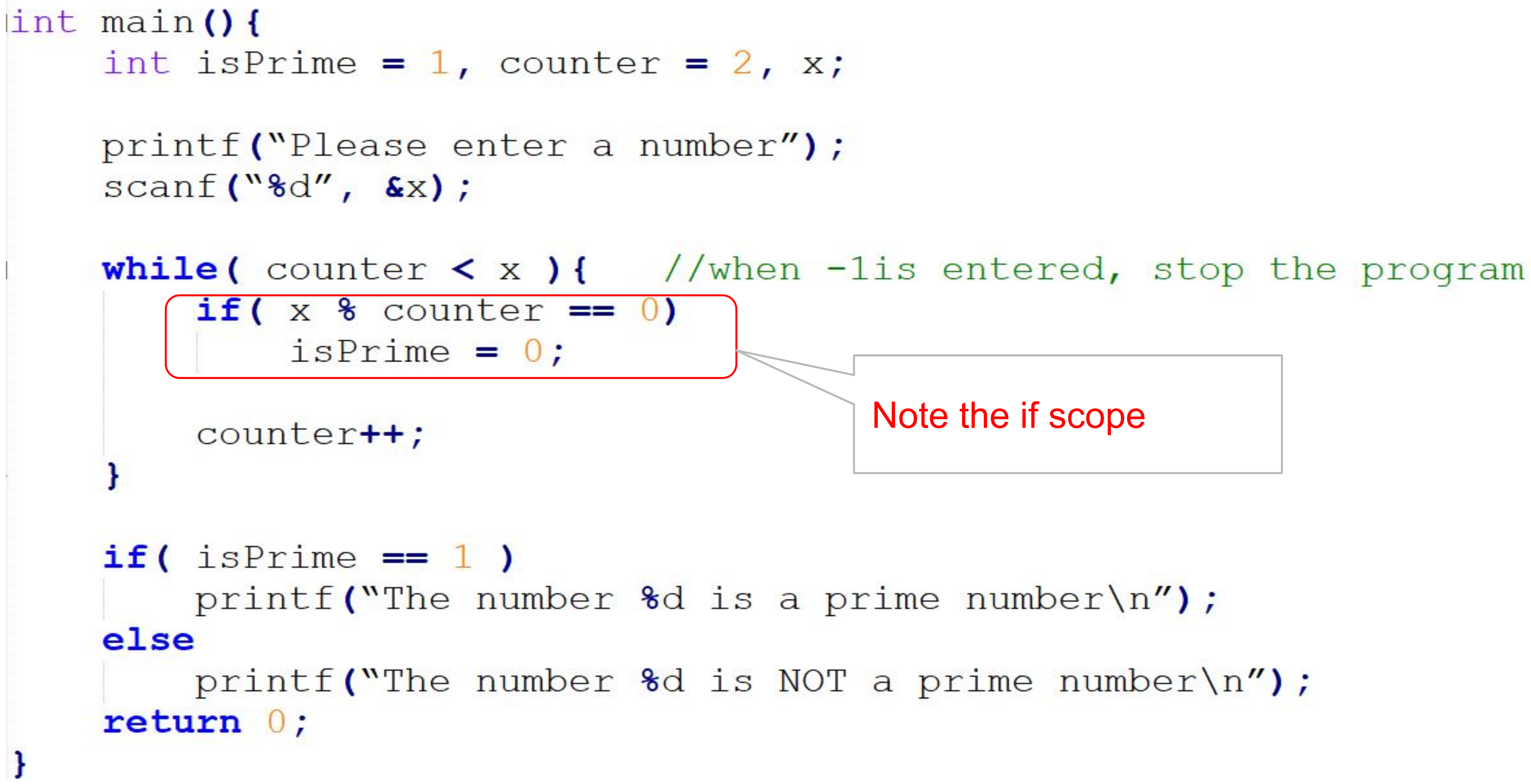
Write a program to compute the factorial of a given number n.



```
int main(){
    int factorial = 1, counter = 1, x;

    printf(“Please enter a number”);
    scanf(“%d”, &x);

    while( counter <= x ){
        factorial = factorial * counter;

        counter = counter + 1;
    }
    printf(“The factorial of %d is %d”, x, factorial);
    return 0;
}
```

While Loop Example

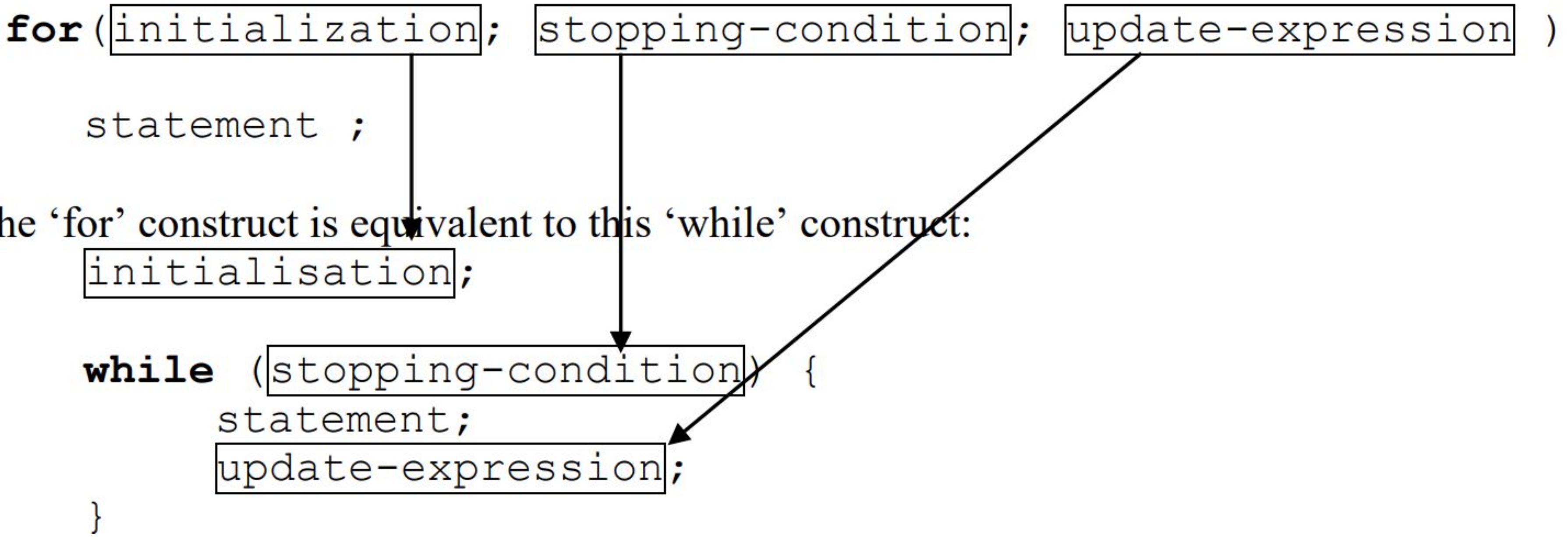
Write a program to check if an input number is prime or not.



```
int main(){
    int isPrime = 1, counter = 2, x;

    printf("Please enter a number");
    scanf("%d", &x);

    while( counter < x ){    //when -1is entered, stop the program
        if( x % counter == 0)
            isPrime = 0;

        counter++;
    }

    if( isPrime == 1 )
        printf("The number %d is a prime number\n");
    else
        printf("The number %d is NOT a prime number\n");
    return 0;
}
```

Note the if scope

For Loop



```
for (initialization; stopping-condition; update-expression )
    statement ;
```

The ‘for’ construct is equivalent to this ‘while’ construct:

```
    initialisation;

    while (stopping-condition) {
            statement;
            update-expression;
    }
```

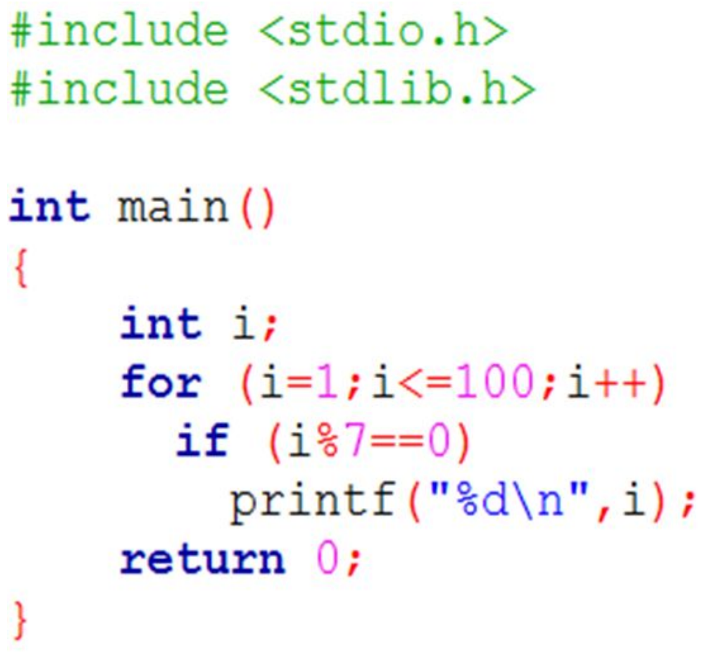
For Loop

```
for(expr1; expr2; expr3)
{
    body
}
```

Normal forms are:

```
for(i = 0; i < 10; i++) {...}
for(i = n-1; i >= 0; i--) {...}
```

For Loop



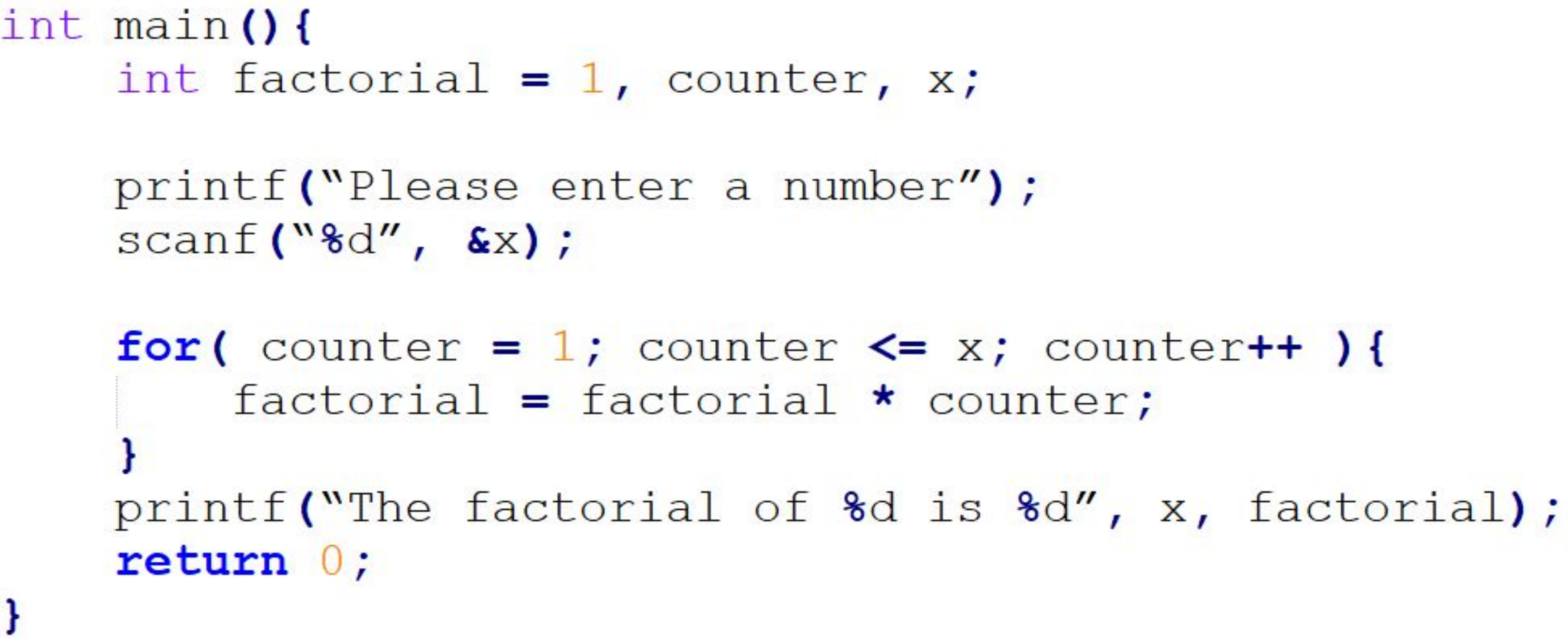
```c
#include <stdio.h>
#include <stdlib.h>

int main()
{
    int i;
    for (i=1;i<=100;i++)
      if (i%7==0)
        printf("%d\n",i);
    return 0;
}
```

Output

```
7
14
21
28
35
42
49
56
63
70
77
84
91
98
```

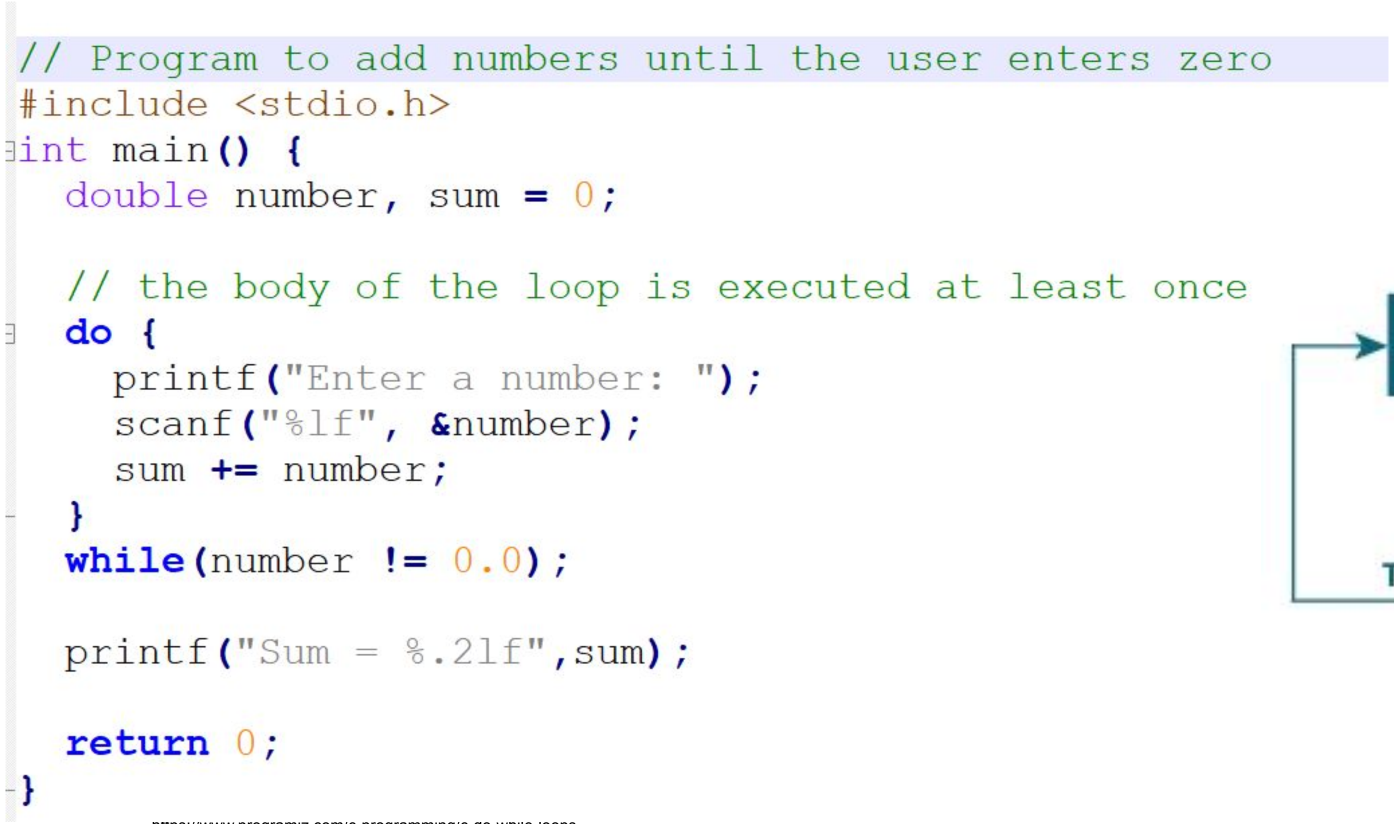
For Loop Example

Write a program to compute the factorial of a given number **n**.

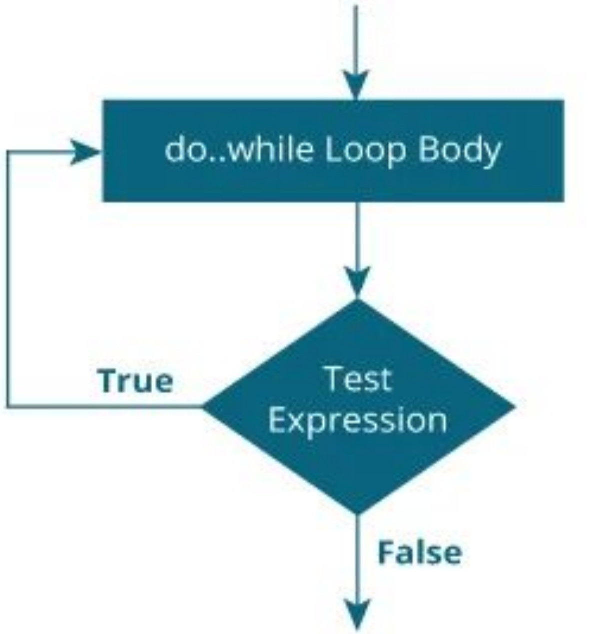


```
int main(){
    int factorial = 1, counter, x;

    printf(“Please enter a number”);
    scanf(“%d”, &x);

    for( counter = 1; counter <= x; counter++ ){
        factorial = factorial * counter;
    }
    printf(“The factorial of %d is %d”, x, factorial);
    return 0;
}
```

Do-While Loop Example



```c
// Program to add numbers until the user enters zero
#include <stdio.h>
int main() {
  double number, sum = 0;

  // the body of the loop is executed at least once
  do {
    printf("Enter a number: ");
    scanf("%lf", &number);
    sum += number;
  }
  while(number != 0.0);

  printf("Sum = %.2lf",sum);

  return 0;
}
```



https://www.programiz.com/c-programming/c-do-while-loops

Chapter 5

- Logical and relational operators

Relational & Equality Operators

Operator	**Meaning**	**Type**
<	Less than	Relational
<=	Less than or equal	Relational
>	Greater than	Relational
>=	Greater than or equal	Relational
==	Equals	Equality
!=	Not equal	Equality

Logical Operators

Operator	Meaning
&&	And
||	Or
!	Negation (not)

Operator Precedence

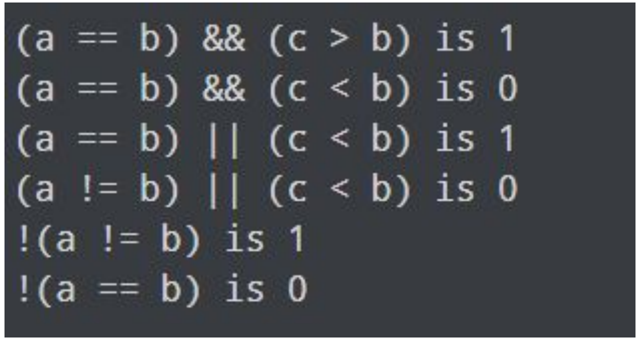
Operator	Precedence
!, +, -, & (unary operators)	Highest
*, /, %	
+, -	
<, <=, >, >=	
==, !=	
&&	
||	
=	Lowest

Logical Operators

```
float x=3.0, y=4.0, z=2.0;
int flag = 0;
//What is the value after applying the following expression:
!flag                           !0 is 1 (true)
x + y / z <= 3.5                5.0 <= 3.5 is 0 (false)
!flag || (y + z >= x -z )       1 || 1 is 1 (true)
!(flag||(y + z >= x -z ))       !(0 || 1) is 0 (false)
```

Logical Operators

```c
int a = 5, b = 5, c = 10, result;

result = (a == b) && (c > b);
printf("(a == b) && (c > b) is %d \n", result);

result = (a == b) && (c < b);
printf("(a == b) && (c < b) is %d \n", result);

result = (a == b) || (c < b);
printf("(a == b) || (c < b) is %d \n", result);

result = (a != b) || (c < b);
printf("(a != b) || (c < b) is %d \n", result);

result = !(a != b);
printf("!(a != b) is %d \n", result);

result = !(a == b);
printf("!(a == b) is %d \n", result);
```



```
(a == b) && (c > b) is 1
(a == b) && (c < b) is 0
(a == b) || (c < b) is 1
(a != b) || (c < b) is 0
!(a != b) is 1
!(a == b) is 0
```

https://www.programiz.com/c-programming/c-operators

Assignment Shorthands

Simple Assignment Operators	Compound Assignment Operators
x = x + 1;	**x += 1;**
x= x -1;	**x -= 1;**
x = x * y;	**x *= y;**
x= x / y;	**x /= y;**
n = n % (x+1);	**n %= x+1;**

Pre and Post-Increment

- **++x** : Pre-increment **x**
  - **a = ++x * b;**
    - **x = x + 1;**
    - **a = x * b;**

- **x++** : Post-increment **x**
  - **a = x++ * b;**
    - **a = x * b;**
    - **x = x + 1;**

- **--x** : Pre-decrement **x**
  - **a = --x * b;**
    - **x = x - 1;**
    - **a = x * b;**

- **x--** : Post-decrement **x**
  - **a = x-- * b;**
    - **a = x * b;**
    - **x = x - 1;**

Pre and Post-Increment

```
int a=2, b=3, c;
c = ++a * b++;

Find a,b,c ?
```

a=2	b=3	c=
a=3 🟥	b=3	c=
a=3	b=3	c=9 🟥
a=3	b=4 🟥	c=9

a=3 , b=4, and c = 9

Pre and Post-Increment

- Find x,y,z ?

```
int x=2,y=3,z=0;
z += --x * y++;
```

Result : x=1 , y=4, and z = 3

- Find a,b,c ?

```
int a=4,b=3,c=20;
c /= ++a;
```

Result : a=5 , b=3, and c = 4

- Find x,y,z ?

```
int x=2,y=3,z=4;
z *= ++x * y++;
```

Result : x=3 , y=4, and z = 36

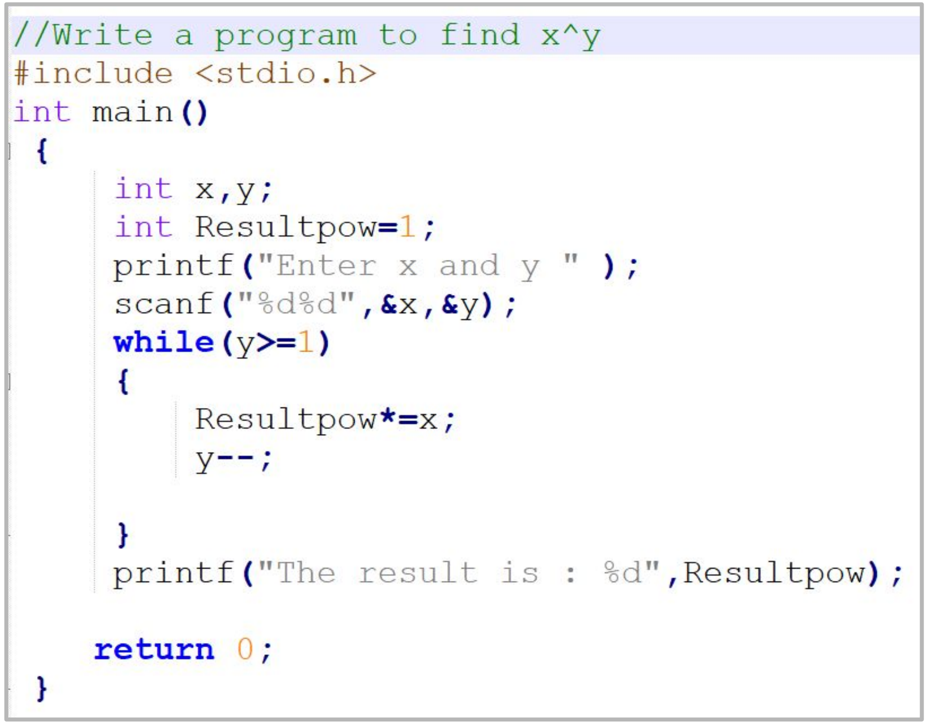
Pre and Post-Increment

```
int i = 1;

while (i < 5)

printf ("%d " , i++);
```

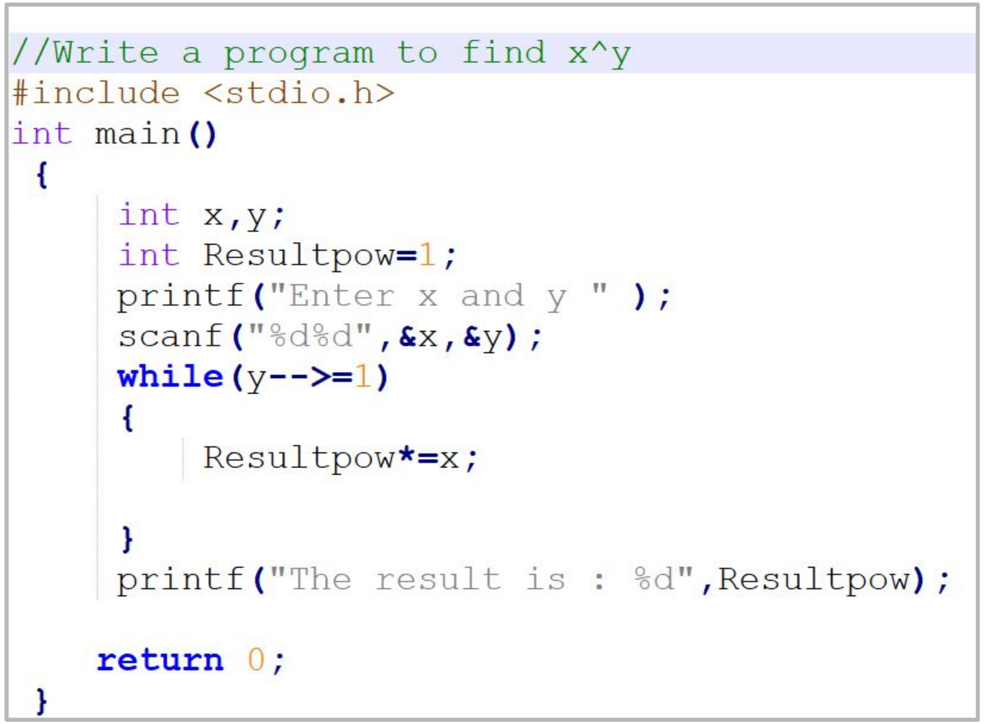
- What is the output?
  - 1 2 3 4
- What is the final value of **i** ?
  - i=5

Pre and Post-Increment

- Write a program to find x^y



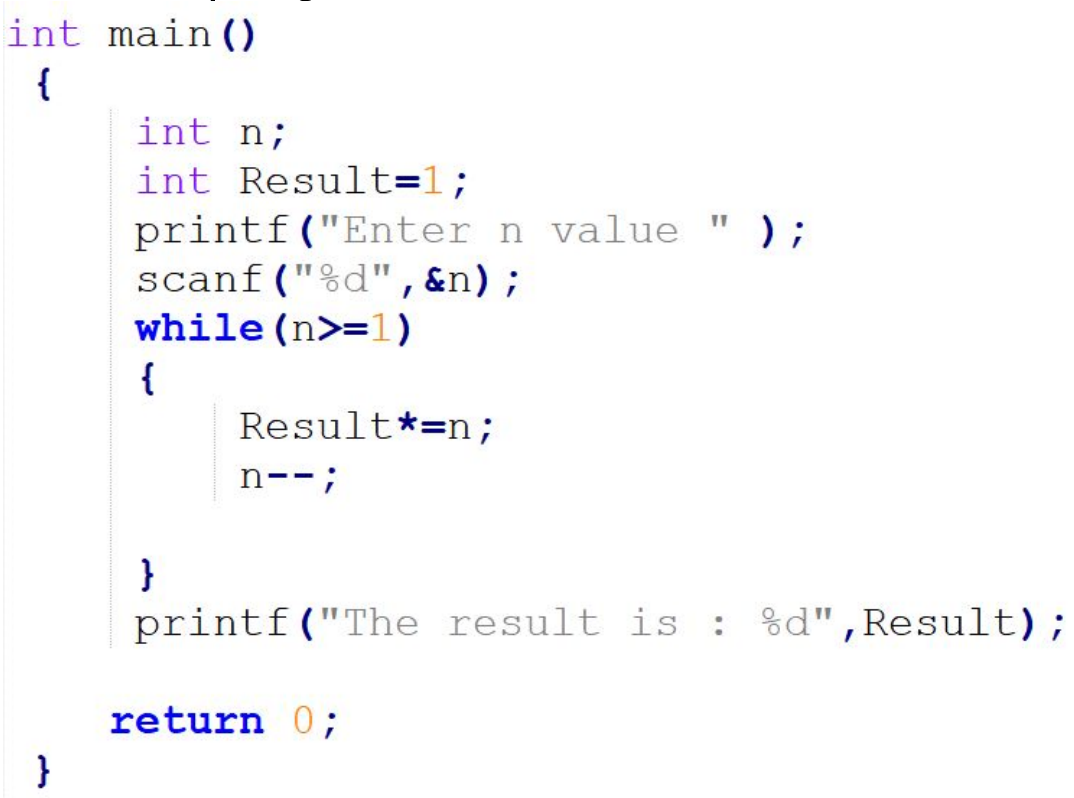
```c
//Write a program to find x^y
#include <stdio.h>
int main()
 {
     int x,y;
     int Resultpow=1;
     printf("Enter x and y " );
     scanf("%d%d",&x,&y);
     while(y>=1)
     {
         Resultpow*=x;
         y--;

     }
     printf("The result is : %d",Resultpow);

    return 0;
 }
```



```c
//Write a program to find x^y
#include <stdio.h>
int main()
 {
     int x,y;
     int Resultpow=1;
     printf("Enter x and y " );
     scanf("%d%d",&x,&y);
     while(y-->=1)
     {
         Resultpow*=x;

     }
     printf("The result is : %d",Resultpow);

    return 0;
 }
```

Pre and Post-Increment

- Write a program to find n!



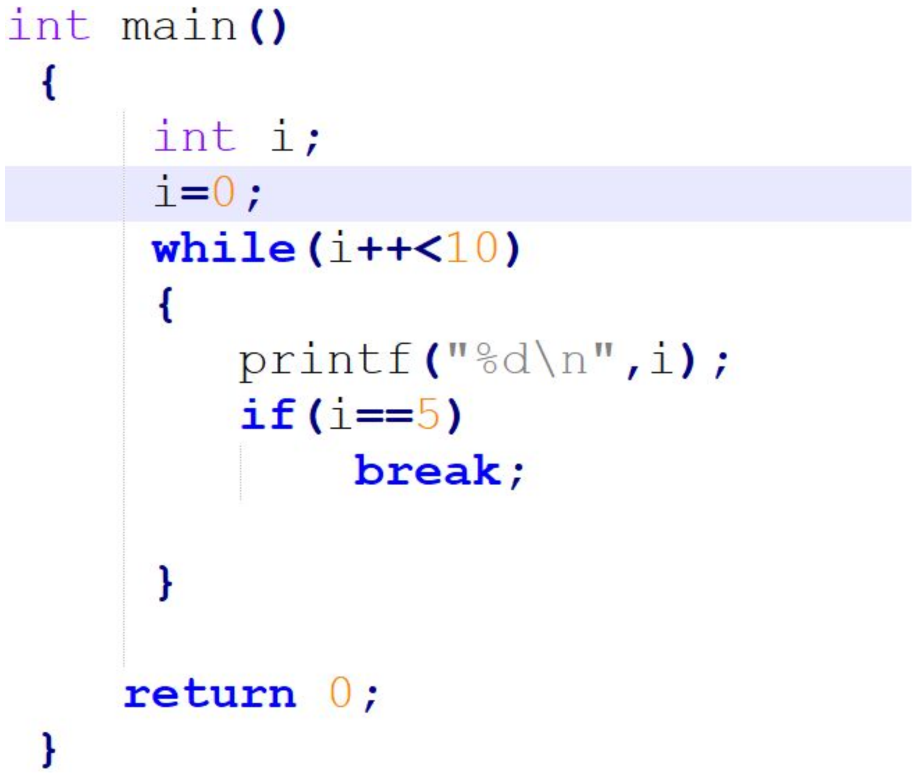
```
int main()
 {
     int n;
     int Result=1;
     printf("Enter n value " );
     scanf("%d",&n);
     while(n>=1)
     {
         Result*=n;
         n--;

     }
     printf("The result is : %d",Result);

    return 0;
 }
```

Break and Continue

- The break and continue statements are used to alter the flow of control.
- The ‘break’ statement: terminates a loop under some special condition
- The ‘continue’ statement: skips a section of the loop body in an iteration.
- The ‘break’ statement in a ‘switch’, ‘while’, ‘do-while’ or ‘for’ structure causes immediate exit from the structure

Break and Continue

- What would be displayed by the following program?



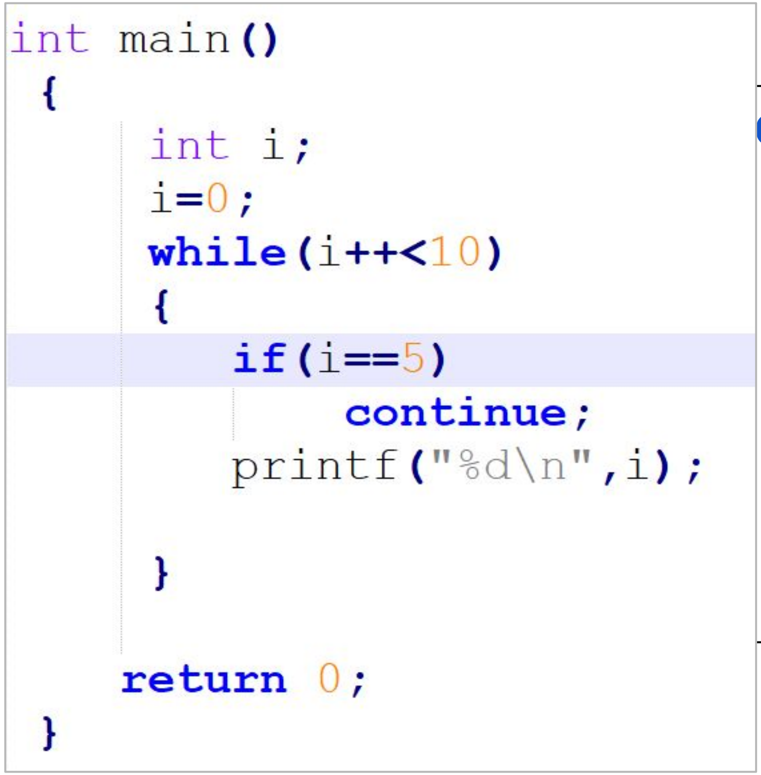
```
int main()
 {
     int i;
     i=0;
     while(i++<10)
     {
         printf("%d\n",i);
         if(i==5)
             break;

     }

    return 0;
 }
```

Output:

```
1
2
3
4
5
```

Break and Continue

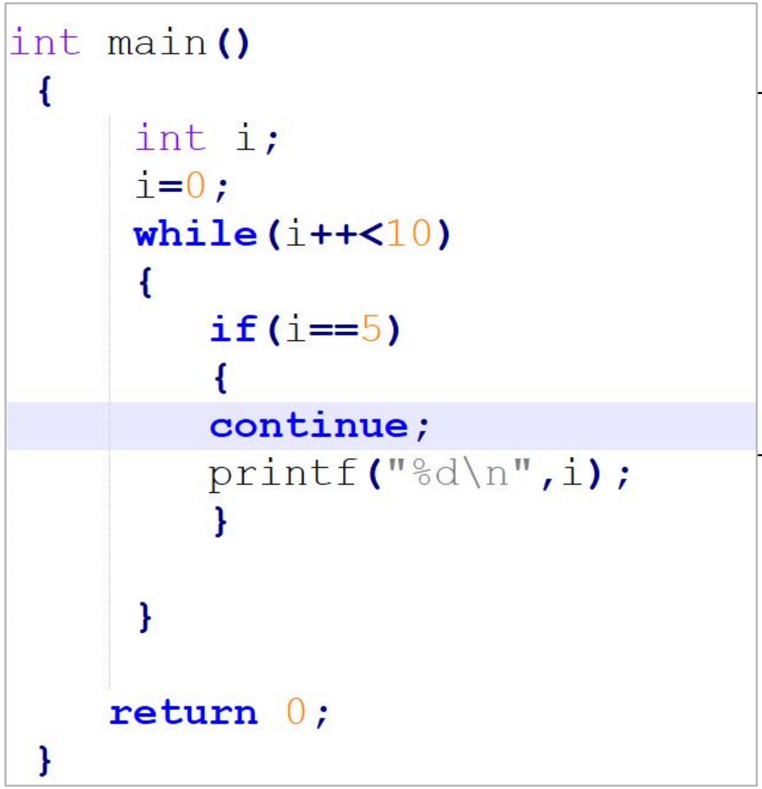
- What would be displayed by the following program?



```c
int main()
 {
     int i;
     i=0;
     while(i++<10)
     {
         if(i==5)
             continue;
         printf("%d\n",i);

     }

    return 0;
 }
```

Output:

```
1
2
3
4
6
7
8
9
10
```



```c
int main()
 {
     int i;
     i=0;
     while(i++<10)
     {
         if(i==5)
         {
         continue;
         printf("%d\n",i);
         }

     }

    return 0;
 }
```

Output:

????

Break and Continue

- What would be displayed by the following program?

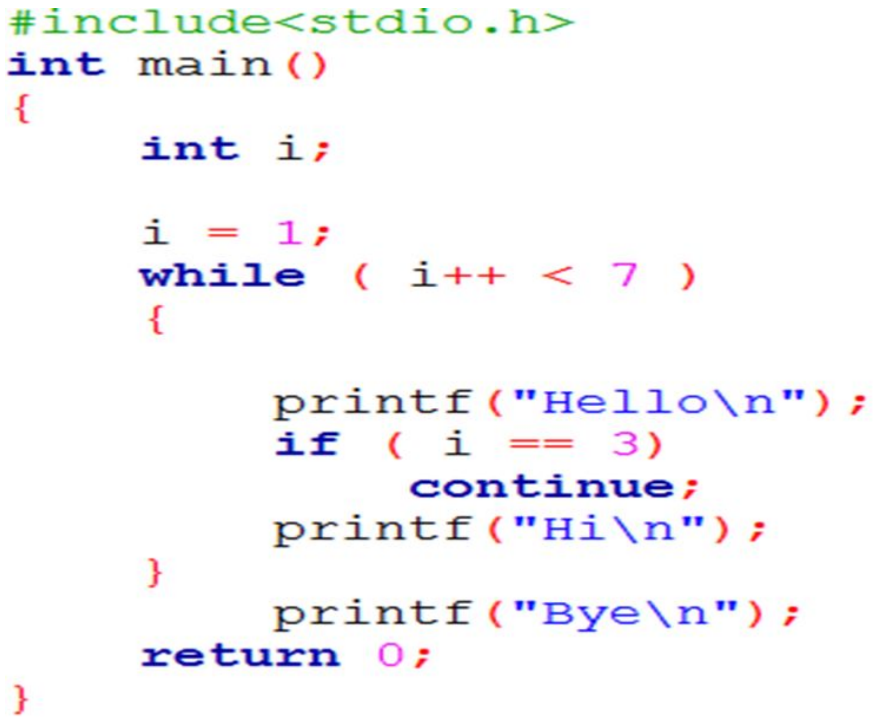
```
#include<stdio.h>
int main()
{
    int i;

    i = 1;
    while ( i++ < 7 )
    {

        printf("Hello\n");
        if ( i == 3)
            break;
        printf("Hi\n");
    }
        printf("Bye\n");
    return 0;
}
```

Output:

```
Hello
Hi
Hello
Bye
```

Break and Continue

- What would be displayed by the following program?



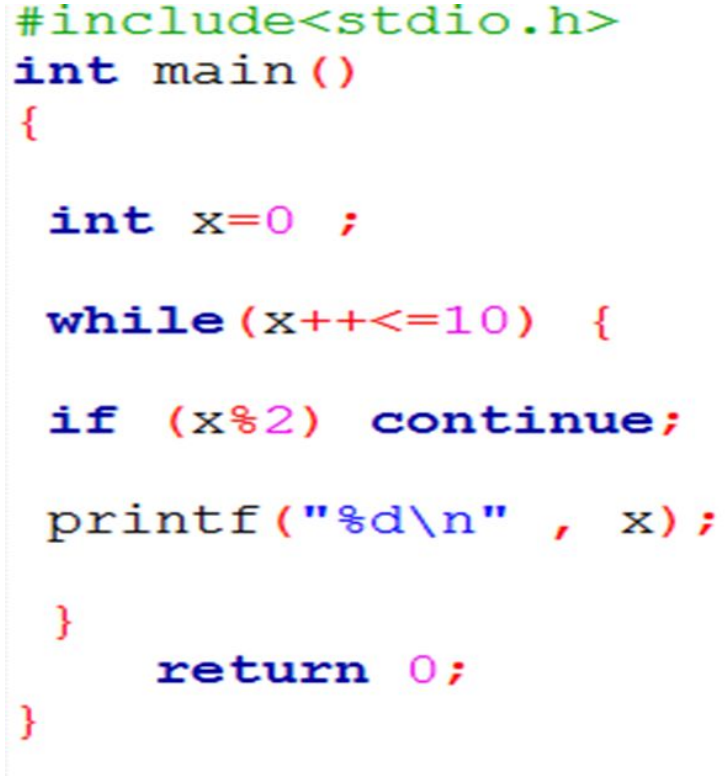
```
#include<stdio.h>
int main()
{
      int i;

      i = 1;
      while ( i++ < 7 )
      {

            printf("Hello\n");
            if ( i == 3)
                  continue;
            printf("Hi\n");
      }
            printf("Bye\n");
      return 0;
}
```

Output:

```
Hello
Hi
Hello
Hello
Hi
Hello
Hi
Hello
Hi
Hello
Hi
Bye
```

Break and Continue

- What would be displayed by the following program?



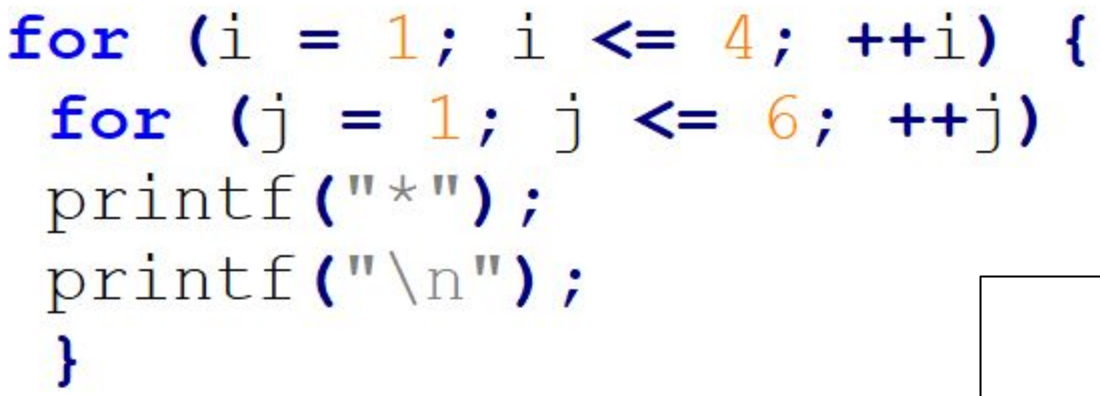
```
#include<stdio.h>
int main()
{

 int x=0 ;

 while(x++<=10) {

 if (x%2) continue;

 printf("%d\n" , x);

  }
      return 0;
}
```

Output:

```
2
4
6
8
10
```

Nested Loop

- What would be displayed by the following program?



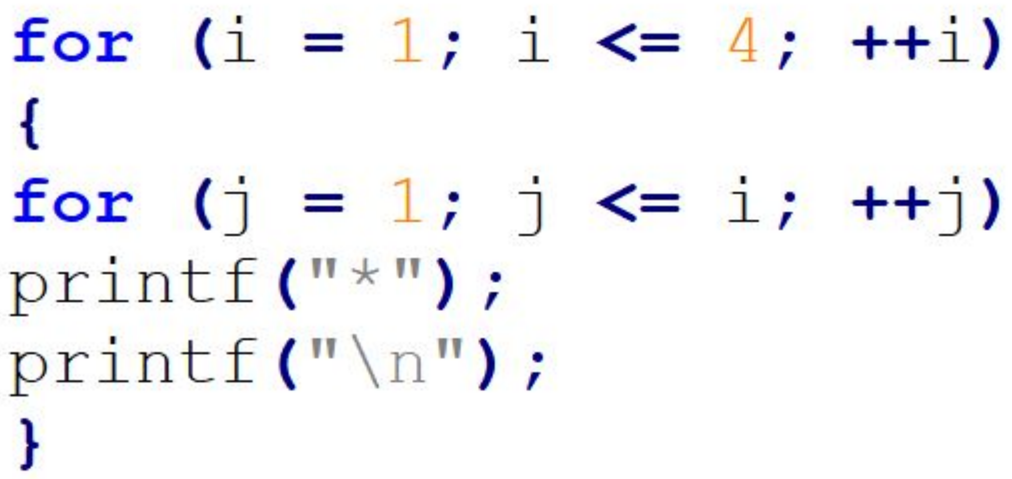
```
for (i = 1; i <= 4; ++i) {
 for (j = 1; j <= 6; ++j)
 printf("*");
 printf("\n");
 }
```

Output:

```
******

******

******

******
```

Nested Loop

- What would be displayed by the following program?



```
for (i = 1; i <= 4; ++i)
{
for (j = 1; j <= i; ++j)
printf("*");
printf("\n");
}
```

Output:

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

Nested Loop

- What would be displayed by the following program?

```
int a=50;
int i;
for (i=2; i<=a;i+=2)
{
printf("%5d",i);

if (i%5==0)

printf ("\n");
}
```

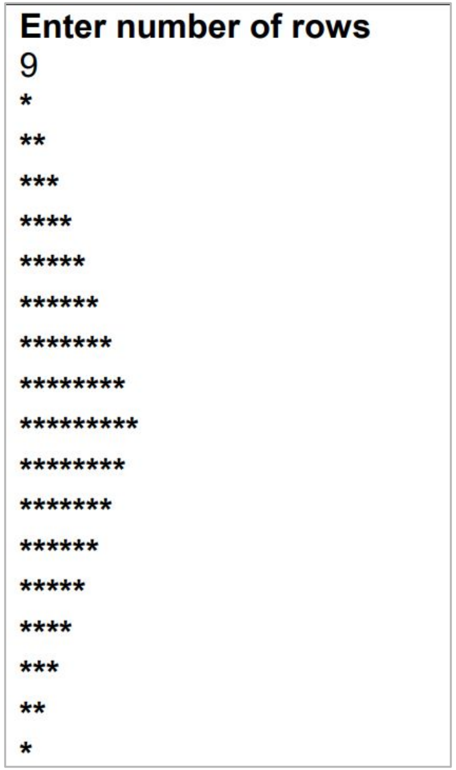
Output:

```
2 4 6 8 10
12 14 16 18 20
22 24 26 28 30
32 34 36 38 40
42 44 46 48 50
```

Nested Loop

- What would be displayed by the following program?

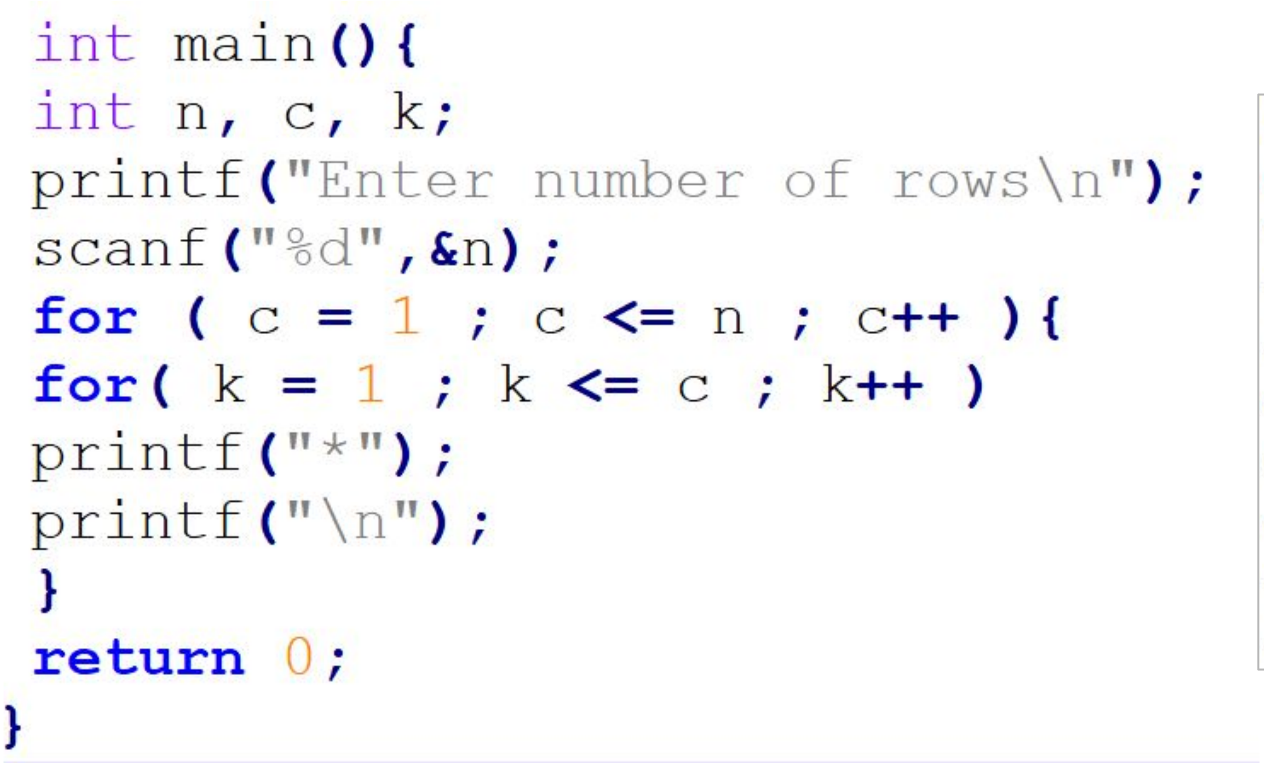
```c
int n, c, k;
printf("Enter number of rows\n");
scanf("%d",&n);
for ( c = 1 ; c <= n ; c++){
for ( k = 1 ; k <= c ; k++ )
printf("*");

printf("\n");
}
for ( c = n - 2 ; c >= 0 ; c-- ){
for ( k = c ; k >= 0 ; k-- )
printf("*");
printf("\n");
}
return 0;
```



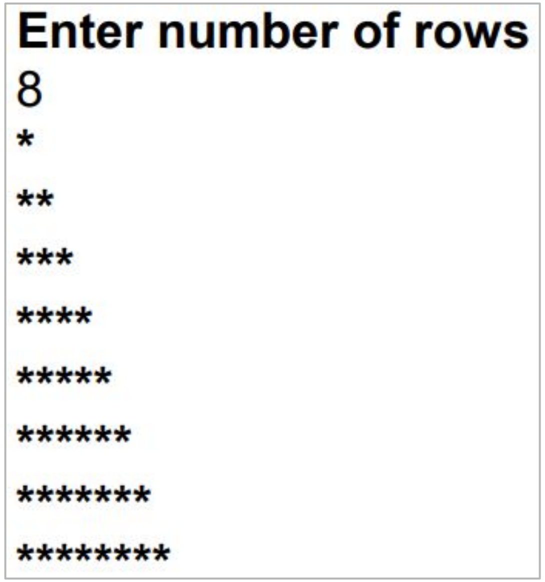
```
Enter number of rows
9
*
**
***
****
*****
******
*******
********
*********
********
*******
******
*****
****
***
**
*
```

Nested Loop

- What would be displayed by the following program?



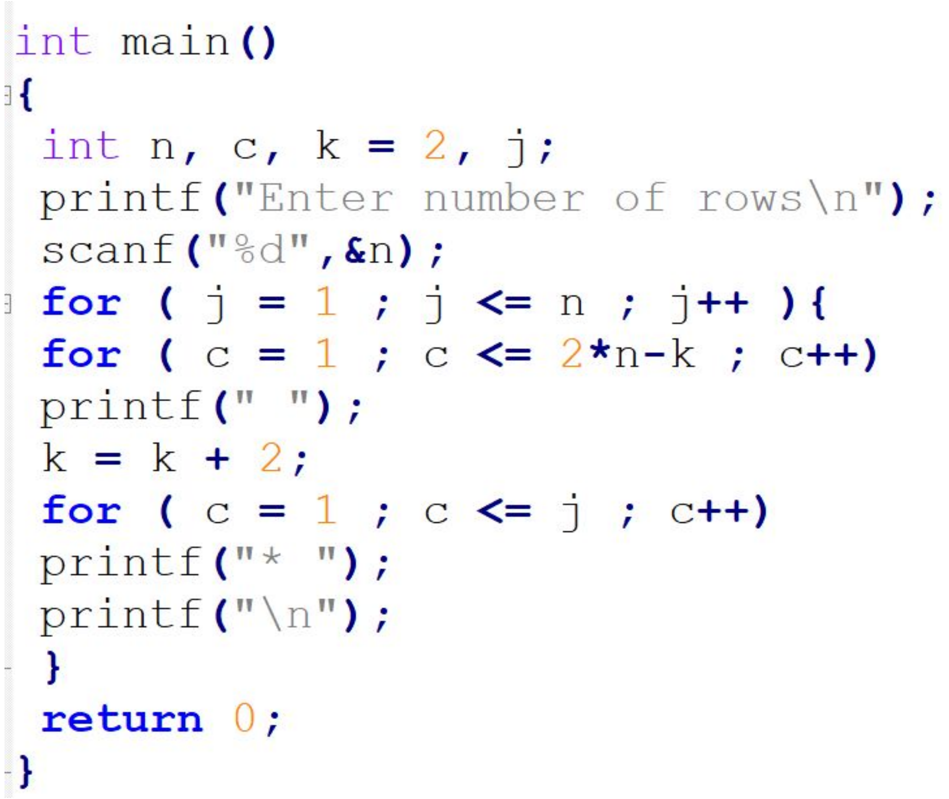
```
int main(){
int n, c, k;
printf("Enter number of rows\n");
scanf("%d",&n);
for ( c = 1 ; c <= n ; c++ ){
for( k = 1 ; k <= c ; k++ )
printf("*");
printf("\n");
}
return 0;
}
```



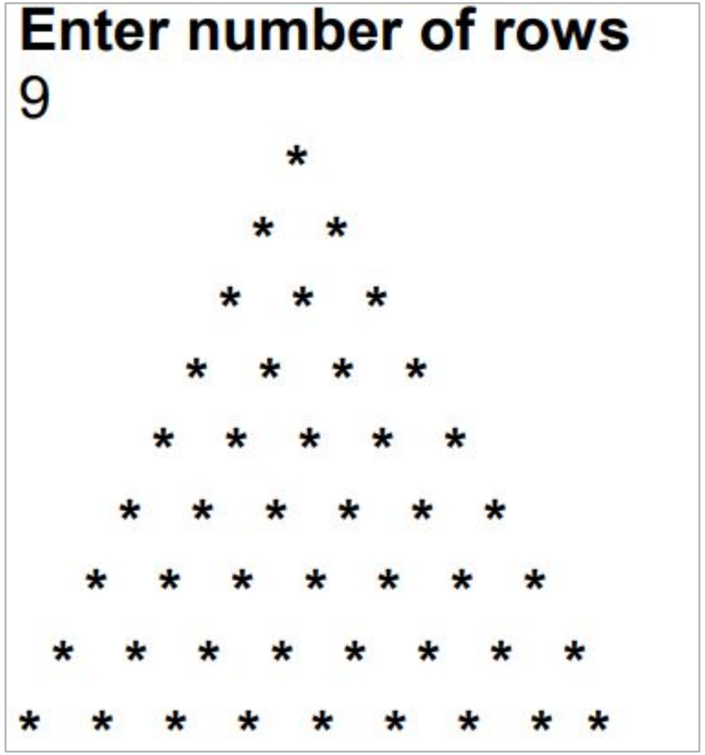
```
Enter number of rows
8
*
**
***
****
*****
******
*******
********
```

Nested Loop

- What would be displayed by the following program?

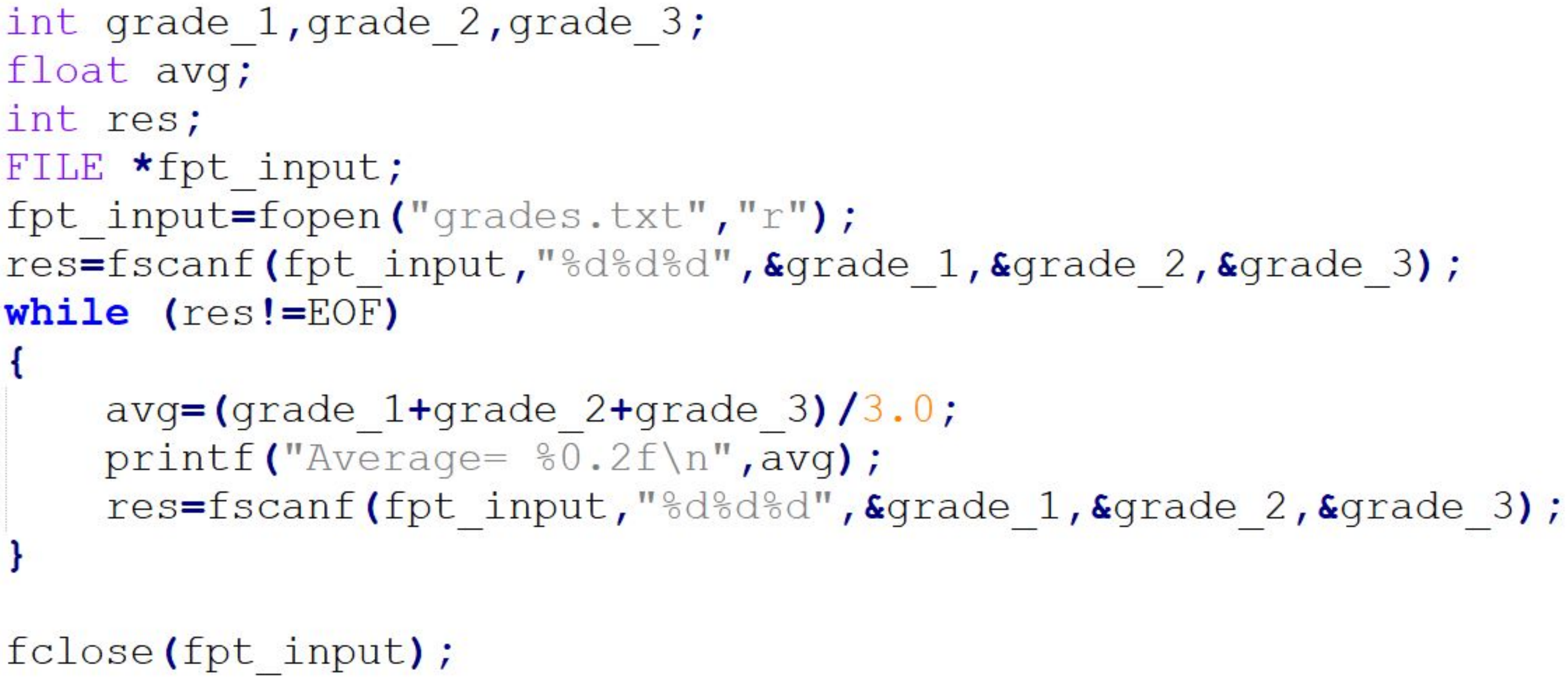


```c
int main()
{
 int n, c, k = 2, j;
 printf("Enter number of rows\n");
 scanf("%d",&n);
 for ( j = 1 ; j <= n ; j++ ){
 for ( c = 1 ; c <= 2*n-k ; c++)
 printf(" ");
 k = k + 2;
 for ( c = 1 ; c <= j ; c++)
 printf("*  ");
 printf("\n");
 }
 return 0;
}
```



```
Enter number of rows
9
                *
              *   *
            *   *   *
          *   *   *   *
        *   *   *   *   *
      *   *   *   *   *   *
    *   *   *   *   *   *   *
  *   *   *   *   *   *   *   *
*   *   *   *   *   *   *   *   *
```

End Of File



```c
int grade_1,grade_2,grade_3;
float avg;
int res;
FILE *fpt_input;
fpt_input=fopen("grades.txt","r");
res=fscanf(fpt_input,"%d%d%d",&grade_1,&grade_2,&grade_3);
while (res!=EOF)
{
    avg=(grade_1+grade_2+grade_3)/3.0;
    printf("Average= %0.2f\n",avg);
    res=fscanf(fpt_input,"%d%d%d",&grade_1,&grade_2,&grade_3);
}

fclose(fpt_input);
```

Thank You.