



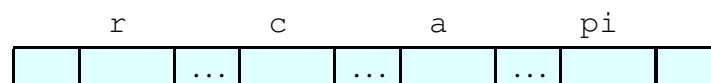
1 Introduction

A *source code* consists of a sequence of instructions written in a specific *programming language*, such as C++. A *compiler* converts a source code to an *object code* consisting of a sequence of instructions written in *machine language*. A *linker* combines object codes with the required library routines into an *executable* which can be run by the user.

2 Program to calculate the circumference and area of a circle

```
1 #include <iostream>
2 using namespace std;
3
4 int main()
5 {
6     float r;
7     float c;
8     float a;
9     float pi = 3.14;
10
11     cout << "Enter the circle radius: ";
12     cin >> r;
13
14     c = 2 * pi * r;
15     a = pi * r * r;
16
17     cout << "The circle circumference = " << c << endl;
18     cout << "The circle area = " << a << endl;
19
20     return 0;
21 }
```

This program contains 4 *variables*: r, c, a, pi. A variable occupies a number of bytes in memory and can store *values*. The value of a variable may change according to the program instructions. These variables will be allocated in memory as follows:



- **Lines 1, 2:** The program tells the compiler that the program uses the built-in C++ input and output library to get input from the user (**Line 12**) and to produce output on the screen (**Lines 11, 17, 18**).
- **Lines 4:** The program starts the definition of the `main()` function which consists of the sequence of the program instructions that will be executed in order. The brackets `{` and `}` (**Lines 5, 21**) specify the start and end of the program instructions.
- **Lines 6, 7, 8:** The program allocates in main memory a space for the variables `r`, `c`, `a`.
- **Line 9:** The program allocates in main memory a space for the variable `pi`, and stores the value 3.14 in it.



- **Line 11:** The program prints “Enter the circle radius:”.
- **Line 12:** The program waits until the user enters a decimal number. The program stores this number as value of the variable `r` (in case the user enters “5” and presses enter, the variable `r` will contain the value 5).



- **Line 14:** The program calculates the value $2 \times \text{pi} \times r$ and stores it in the variable `c`. Assuming that `r = 5`, the value $2 \times \text{pi} \times r = 2 \times 3.14 \times 5 = 31.4$ will be stored in `c`.



- **Line 15:** The program calculates the value $\text{pi} \times r^2$ and stores it in the variable `a`. Assuming that `r = 5`, the value $\text{pi} \times r^2 = 3.14 \times 5^2 = 3.14 \times 25 = 78.5$ will be stored in `a`.



- **Line 17:** The program prints “The circle circumference = ” followed by the value of `c`. Assuming that `r = 5`, the value of `c` is 31.4.
- **Line 18:** The program prints “The circle area = ” followed by the value of `a`. Assuming that `r = 5`, the value of `a` is 78.5.

When this program is executed, the interaction with the user could be as follows:

```
Enter the circle radius: 5
The circle circumference = 31.4
The circle area = 78.5
```

3 Program to calculate the sum, average and maximum of three integers

```

1 #include <iostream>
2 using namespace std;
3
4 int main()
5 {
6     int a, b, c;
7     int s; float v; int m;
8
9     cout << "Enter three integers: ";
10    cin >> a >> b >> c;
11
12    s = a + b + c;    // Calculate the sum
13    v = s / 3.0;      // Calculate the average
14
15    m = a;
16    if (b > m) m = b;
17    if (c > m) m = c;
18
19    cout << "The sum = " << s << endl;
20    cout << "The average = " << v << endl;
21    cout << "The maximum = " << m << endl;
22
23    return 0;
24 }

```

The program steps proceed as follows:

- **Lines 6, 7:** The program allocates in main memory a space for the variables a, b, c, s, v, m.



- **Line 9:** The program prints “Enter three integers:”.
- **Line 10:** The program waits until the user enters three integers separated by spaces. The program stores these numbers as values of the variables a, b, c (in case the user enters “5 12 8” and presses enter, the variable a will contain the value 5, the variable b will contain the value 12, and the variable c will contain the value 8).



- **Line 12:** The program calculates the value of $a + b + c$ and stores it in the variable s. Assuming that $a = 5$, $b = 12$, $c = 8$, the value $a + b + c = 5 + 12 + 8 = 25$ will be stored

in the variable s . The text after `//` helps the programmer to read and remember the code and is not part of the program.

a		b		c		s		v		m		
	5	...	12	...	8	...	25		

- **Line 13:** The program calculates the value of $s/3.0$ and stores it in the variable v . Assuming that $s = 25$, the value $s/3.0 = 25/3.0 = 8.33$ will be stored in the variable v . The text after `//` helps the programmer to read and remember the code and is not part of the program.

a		b		c		s		v		m		
	5	...	12	...	8	...	25	...	8.33	...		

- **Line 15:** The program stores the value of a in the variable m . Assuming that $a = 5$, the value 5 will be stored in the variable m .

a		b		c		s		v		m		
	5	...	12	...	8	...	25	...	8.33	...	5	

- **Line 16:** If the value of the variable b is greater than the current value of the variable m , the program will store the value of the variable b in the variable m . Assuming that the current value of $m = 5$ and the value of $b = 12$, the value 12 will be stored in the variable m .

a		b		c		s		v		m		
	5	...	12	...	8	...	25	...	8.33	...	12	

- **Line 17:** If the value of the variable c is greater than the current value of m , the program will store the value of c in the variable m . Assuming that the current value of $m = 12$ and the value of $c = 8$, the value of m will not change.

a		b		c		s		v		m		
	5	...	12	...	8	...	25	...	8.33	...	12	

- **Line 19:** The program prints "The sum = " followed by the value of s . Assuming that $a = 5$, $b = 12$, $c = 8$, the value of s is 25.
- **Line 20:** The program prints "The average = " followed by the value of v . Assuming that $a = 5$, $b = 12$, $c = 8$, the value of v is 8.33.
- **Line 21:** The program prints "The maximum = " followed by the value of m . Assuming that $a = 5$, $b = 12$, $c = 8$, the value of m is 12.

When this program is executed, the interaction with the user could be as follows:

```
Enter three integers: 5 12 8
The sum = 25
The average = 8.33
The maximum = 12
```