

Programming 4kids

Data types and variables

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Data Types

- We call 1234 a number. C++ calls it **integer**
- What about 10.7? This is too a number, but with fraction part
 - C++ calles it **double** (or float)
- What is 'X'? This is letter. C++ calls it **character**
- What is "Car"? This is a word. C++ calls it sequence of characters or **strings**
- Some things are of two types only. E.g. a person is single or married
 - C++ call them **boolean**. Their values are true or false
 - E.g. coin is head or tail. We can think head is true and tail is false
 - True also corresponds to 1, and False to 0.
 - Light can be on or off. [Computers](#) "understand" on and off.
- Summary: **integer, double, character, string, boolean**

The need for names!

- Let say we want to build program for hospital
 - We need to refer to patients
 - One of them is called “Mostafa”. He is 55 years old. He has 2 children!
 - We also has Doctors who has name, salary, address, etc
- How can we represent this information?
 - We need to put them in memory when the program starts
 - We need to have names to refer to them?
 - E.g. I want to know mostafa’s age?

Computer Memory Like Streets



- Each home has street address (location)
 - Name and number
 - 127 Tahrir Street
 - 127 = location
 - Tahrir = Name
- There are people in the home
 - People have types
 - Male, Femal, Child

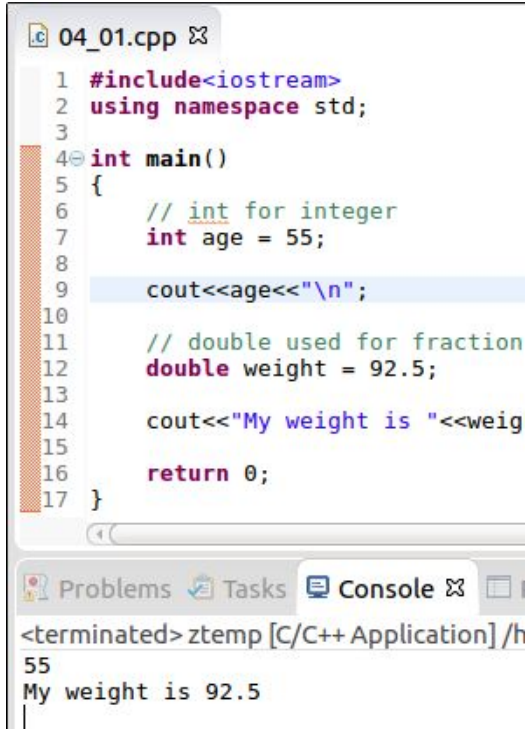
Computer Memory (RAM)

- Think of it as boxes
- Each box has
 - Address location
 - Type (e.g. integer or double)
 - Name: E.g. age, name or salary
- We call it variable
 - A box in the memory

Location	Name/Value	Type
1	EMPTY	NA
2	Age = 55	Integer
3	Weight = 92.5	Double
4	Group = 'D'	Character
5	Gender = Male	Boolean
6	Name = "Mostafa"	String

Memory

Let's define 2 variables: age and weight



```
04_01.cpp
1 #include<iostream>
2 using namespace std;
3
4 int main()
5 {
6     // int for integer
7     int age = 55;
8
9     cout<<age<<"\n";
10
11     // double used for fraction
12     double weight = 92.5;
13
14     cout<<"My weight is "<<weight;
15
16     return 0;
17 }
```

Problems Tasks Console

<terminated> ztemp [C/C++ Application] /h
55
My weight is 92.5

- How to define a variable in memory?
- **int age = 55;**
 - int: type of this variable
 - age: name of variable (identifier)
 - = please assign value
 - 55: please put in memory this value! (literal)
- Notice we can now print the weight!
- Same for weight variable
 - double weight = 92.5;

Declare, Assign, Get

```
04_02.cpp
1 #include<iostream>
2 using namespace std;
3
4 int main()
5 {
6     // Declare variable in memory. Garbage value
7     int number1;
8     int number2;
9
10    // Assign values (in memory)
11    number1 = 30;
12    number2 = 10;
13
14    // Get values
15    cout<<number1 + number2<<"\n";
16    cout<<number1 - number2<<"\n";
17
18    // Reassign value
19    number1 = 50;
20    cout<<"2n+1 = "<<number1 * 2 + 1<<"\n";
21
22    return 0;
23 }
24
```

Problems Tasks Console Properties 1010 0101 Call Graph

<terminated> ztemp [C/C++ Application] /home/moustafa/workspa

40
20
2n+1 = 101
|

- We can also declare variable and later put values
- We can use them for operations

Location	Name/Value	Type
1	number1 = 30	Integer
2	number2 = 10	Integer

Identifier (variable name)

- Identifier: Variable name
 - `int sum = 10;` => `sum` is identifier
- Identifier consist of: letters, digits, `_`
 - `iNumber`, `status1`, `status2`, `mostafa_saad`, `_valid`
- Can't start with digit
 - `7Core` [wrong]
- Case sensitive: `sum` != `SUM`
- Shouldn't use reserved keyword
 - `int` **`return`** = 6;
 - Reserved words: `int`, `float`, `double`, `return`, `void`, `if`, `while`, `break`, `false`, `bool`, and more
-

Other important data types

```
04_03.cpp
1 #include<iostream>
2 using namespace std;
3
4 int main()
5 {
6     double weight = -92.5;
7
8     char group = 'd';
9
10    bool is_male = true;
11    bool like_football = false;
12
13    int age = 55;
14    string name = "mostafa";
15
16    cout<<"I am "<<age<<" years old\n";
17    cout<<"My weight is "<<weight<<"\n";
18
19    cout<<"my name is "<<name
20        <<" and group "<<group<<"\n"
21        <<is_male<<" "<<like_football<<"\n";
22
23    return 0;
24 }
25
```

Problems Tasks Console Properties

```
<terminated> ztemp [C/C++ Application] /home/moustafa/w
I am 55 years old
My weight is -92.5
my name is mostafa and group d
1 0
|
```

- Notice the 0/1 values for the bool
 - So it is eventually a number
- Also char is a number

Datatypes has **min** and **max** values to store

- int: -2147483648 to 2147483647
- char: -127 to 127
- bool: 0 to 1
- If you tried lower value => underflow
- If you tried bigger value => overflow
 - int val = 2147483647 + 1;
 - We are adding 1 more than the max value!
 - Compiler msg: warning: integer overflow in expression



Reading variables

- In previous times we learned how to print
 - We used `cout<<`
 - Remember: C = Console - Out = Output
- To read we use `cin>>`
 - C = console, in = Input
- Steps
 - Define a variable
 - Read it
 - Wait user enter input from the console

Reading an integer

```
04_04.cpp
1 #include<iostream>
2 using namespace std;
3
4 int main()
5 {
6     int num;
7
8     cout<<"Enter your lucky number\n";
9
10    cin>>num;
11
12    cout<<"*****\n";
13    cout<<2 * num + 1<<"\n";
14
15    return 0;
16 }
17
```

Problem Tasks Console Proper 1010 0101 Cal

ztemp [C/C++ Application] /home/moustafa/workspac
Enter your lucky number

- The compiler behaviour:
 - Line 6: Declare variable in memory: num
 - Line 8: Print Enter your lucky number
 - Line 10: Trying to read number
 - Compiler here FREEZES
 - It waits you enter a number

Reading an integer

```
04_04.cpp
1 #include<iostream>
2 using namespace std;
3
4 int main()
5 {
6     int num;
7
8     cout<<"Enter your lucky number\n";
9
10    cin>>num;
11
12    cout<<"*****\n";
13    cout<<2 * num + 1<<"\n";
14
15    return 0;
16 }
17
```

Problems Tasks Console

```
<terminated> ztemp [C/C++ Application] /
Enter your lucky number
10
*****
21
|
```

- Let's input 10
- So num in memory assigned 10
- Print $2 * 10 + 1 \Rightarrow 21$
- Remember
 - Don't enter value low or more than min/max values

Reading multiple numbers

```
04_05.cpp
1 #include<iostream>
2 using namespace std;
3
4 int main() {
5     int a, b;
6
7     cout << "Enter 2 numbers\n";
8
9     cin >> a >> b;
10
11     cout << a * b << " " << a + b << "\n";
12
13     return 0;
14 }
15
```

Problems Tasks Console Properties

<terminated> ztemp [C/C++ Application] /home/moustafa/v

Enter 2 numbers

2 5

10 7

|

- Remember we print multiple things
- We can also read multiple things using a single command
- Here we read 2 numbers and do 2 operations
 - We input 2 and 5

Reading different data types

- We can read several types

```
04_06.cpp
1 #include<iostream>
2 using namespace std;
3
4 int main() {
5     int age;
6     cout<<"Enter age: ";
7     cin>>age;
8
9     double weight;
10    cout<<"Enter weight: ";
11    cin>>weight;
12
13    char group;
14    cout<<"Enter group: ";
15    cin>>group;
16
17    string name;
18    cout<<"Enter name: ";
19    cin>>name;
20
21    cout<<"I am "<<name<<" belongs to group "<<group<<"\n";
22    cout<<"My weight "<<weight<<" and age "<<age;
23
24    return 0;
25 }
```

Problems Tasks Console Properties Call Graph Search

<terminated> ztemp [C/C++ Application] /home/moustafa/workspaces/eclips
Enter age: 55
Enter weight: 92.5
Enter group: D
Enter name: mostafa
I am mostafa belongs to group D
My weight 92.5 and age 55

Assignment operator +

04_7.cpp

```
1 #include<iostream>
2 using namespace std;
3
4 int main() {
5     int num1 = 20;
6     int num2 = num1 + 5;
7
8     cout<<"num2 "<<num2<<"\n";
9
10    num1 = num1 + 1;
11    cout<<"num1 "<<num1<<"\n";
12
13    num2 += 1; // same as num2 = num2+1
14    cout<<"num2 "<<num2<<"\n";
15
16    num2++; // same as num2 = num2+1
17    cout<<"num2 "<<num2<<"\n";
18
19    --num2; // same as num2 = num2-1
20    cout<<"num2 "<<num2<<"\n";
21
22    num1 *= 2; // same as num1 = num1 * 2
23    cout<<"num1 "<<num1<<"\n";
24
25    cout<<num1+num2<<"\n";
26
27    num2 = num1-2;
28    cout<<"num2 "<<num2<<"\n";
29
30    num2 = num1-(-2);
31    cout<<"num2 "<<num2<<"\n";
32
33    return 0;
34 }
35
36
```

Console

```
<terminated> z
num2 25
num1 21
num2 26
num2 27
num2 26
num1 42
68
num2 40
num2 44
|
```

- = helps us to assign values
- Value on right side is put on left side
 - Memory box updated
- Keep in mind the last updated value in the memory for each variable

Homework 1: Math operations

- Write a program that reads 2 numbers and **print** their + - * / as following
 - For inputs 12 and 3
- Do good testing for your code
 - E.g. consider zero as first or 2nd number
 - E.g. consider negative values
 - E.g. even and odd values
 - E.g. try the MAX of int: 2147483647

```
12 3
12 + 3 = 15
12 - 3 = 9
12 / 3 = 4
12 * 3 = 36
```

Homework 2: Students grades

- A teacher want a program that reads 2 students information about math exam
 - Read per student: name, id and grade
 - Then print them. See the picture
- Be a good software engineer
 - Think deeply in your selected data types
 - The teacher gives us this dialogue to guide us
 - Be careful from your assumptions?
 - Is exam's grade an integer?

```
What is student 1 name: mostafa
His id: 111
His math exam grade: 20
What is student 2 name: ALI
His id: 555
His math exam grade: 30
```

```
Students grades in math
mostafa (with id 111) got grade: 20
ALI (with id 555) got grade: 30
Average grade is 25
```

Homework 3: Even and Odd sum

Problem Statement: Given 8 space-separated integers, find the sum of those in even places and the sum of those in odd places.

Note: Even place means the 2nd, 4th, 6th or 8th numbers, while odd places are the 1st, 3rd, 5th and 7th numbers.

Example Input:

```
11 2 7 9 12 -8 3 -1
```

Example Output:

```
2 33
```

Example Explanation:

$$2 + 9 + (-8) + (-1) = 2$$

$$11 + 7 + 12 + 3 = 33$$

Homework 4: Guess Program Output

04_homework4.cpp

```
1 #include<iostream>
2 using namespace std;
3
4 int main() {
5     int num1, num2, num3;
6
7     num1 = 0, num2 = 1, num3 = num1 + num2, cout <<num3<<"\n";
8     num1 = num2, num2 = num3, num3 = num1 + num2, cout <<num3<<"\n";
9     num1 = num2, num2 = num3, num3 = num1 + num2, cout <<num3<<"\n";
10    num1 = num2, num2 = num3, num3 = num1 + num2, cout <<num3<<"\n";
11    num1 = num2, num2 = num3, num3 = num1 + num2, cout <<num3<<"\n";
12    num1 = num2, num2 = num3, num3 = num1 + num2, cout <<num3<<"\n";
13    num1 = num2, num2 = num3, num3 = num1 + num2, cout <<num3<<"\n";
14    num1 = num2, num2 = num3, num3 = num1 + num2, cout <<num3<<"\n";
15    num1 = num2, num2 = num3, num3 = num1 + num2, cout <<num3<<"\n";
16
17    // https://en.wikipedia.org/wiki/Fibonacci\_number
18
19    return 0;
20 }
```

Homework 5: Guess Program Output

04_homework5.cpp

```
1 #include<iostream>
2 using namespace std;
3
4 int main() {
5     int num = 0;
6
7     ++num;
8     num *= 10;
9     num += 2;
10    num = num * 10;
11    num += 3;
12    num = num * 10 + 4;
13    num = 5 + num * 10;
14    num = (num * 10 + 6) * 10 + 7;
15    num = 5 * num * 2 * 1 + 5 + 2 + 1;
16
17    cout<<num<<"\n";
18
19    return 0;
20 }
21
22
```

Homework 6: Swapping 2 numbers!

- Write a program that reads 2 variables num1 and num2
 - E.g. say we read num1 = 7 and num2 = 231
- Target: we want swap the values of Num1 and Num2?
 - Swap means exchange
 - So Num1 takes value 231 and Num2 takes value 7

```
int main() {  
    int num1, num2, num3 = -1;  
  
    cin>>num1>>num2;           // let say we read 7 and 231  
  
    // TODO write 3 lines that swaps them  
  
    cout<<num1<<" "<<num2<<endl;    // This should print 231 7  
  
    return 0;  
}
```

Homework 7: Swapping 3 numbers!

- Same as previous, but on 3 numbers
- Let say we have numbers $a = 115$, $b = 20$, $c = 301$
- We wanna their final values to be: $a = 20$, $b = 301$, $c = 115$

Homework 8: Print Me

- Write a program that reads 2 integers A, B
 - B is either -1 or 1
 - If -1, print $2*A+1$
 - If 1, print $A*A$
- However, you need to assume the following
 - Don't use if conditions, if you know them
 - Don't use comparison operators (e.g. $==$, $<=$, $>=$, etc)
- Thinking hint
 - Thinking without constraints/assumptions makes thinking easier
- Hint
 - You need to think in a **simple 1 line formula** for the output

Homework 9: Sum numbers from 1 to N

- Write a program that reads integer N and Print the sum from 1 to N
 - E.g. If input N = 5, then Output is: 15
 - Why? As $1+2+3+4+5 = 15$
 - Below table of more values
 - $3 \Rightarrow 6$ ($1+2+3$)
 - $4 \Rightarrow 10$ ($1+2+3+4$)
 - $5 \Rightarrow 15$ ($1+2+3+4+5$)
- You need to find a **simple 1 line formula** to solve the problem :)
 - Hint: Let N = 8. Write numbers from 1 to 8
 - What is the sum of 1st and 8th number? sum of 2nd and 7th? And so on
 - Your formula should be good for even and odd N. Be careful programmer!
 - What is the maximum N after it overflow occurs? Recall int max is **2147483647**

تم بحمد الله

علمكم الله ما ينفعكم

ونفعكم بما تعلمتم

وزادكم علماً

