Programming Principles (MT162)

Lecture 5

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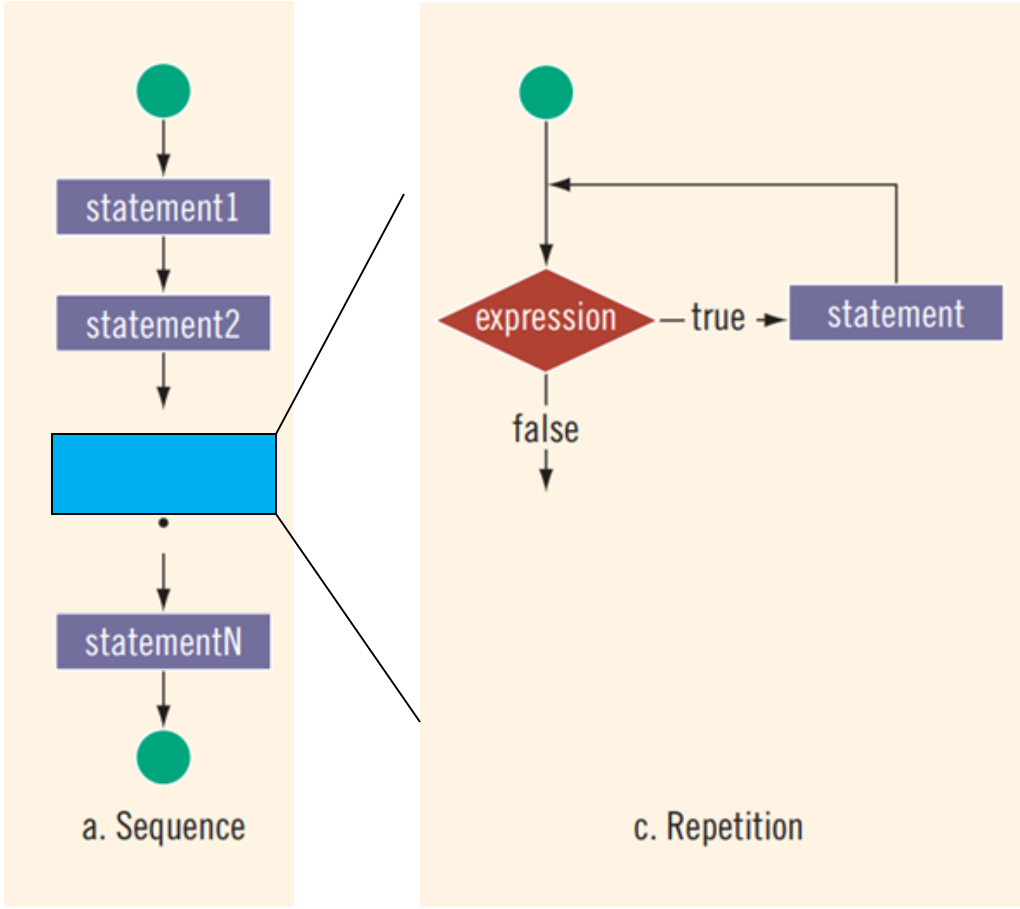
Control Structures II (Repetition)

Control Structures



Why Is Repetition Needed? (*motivational example*)

- Write a program to read 3 numbers and output sum and mean values.
  - Declare 3 variables for each number (e.g., a, b, c).
  - Input the 3 numbers.
  - Find sum and mean of the 3 numbers

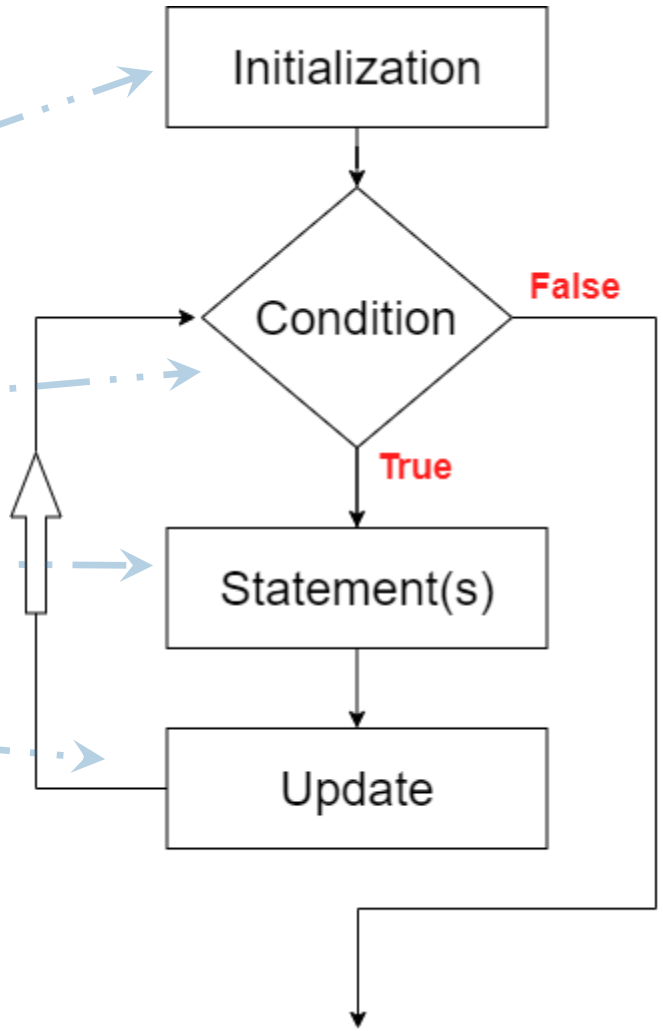
- What if I need to do the same task for 100 numbers.

Why Is Repetition Needed?

- Repetition allows you to efficiently use variables.
- Can input, add, and average multiple numbers using a limited number of variables
- For example, to add five numbers:
  - Declare a variable for each number, input the numbers and add the variables together
  - Create a loop that reads a number into a variable and adds it to a variable that contains the sum of the numbers

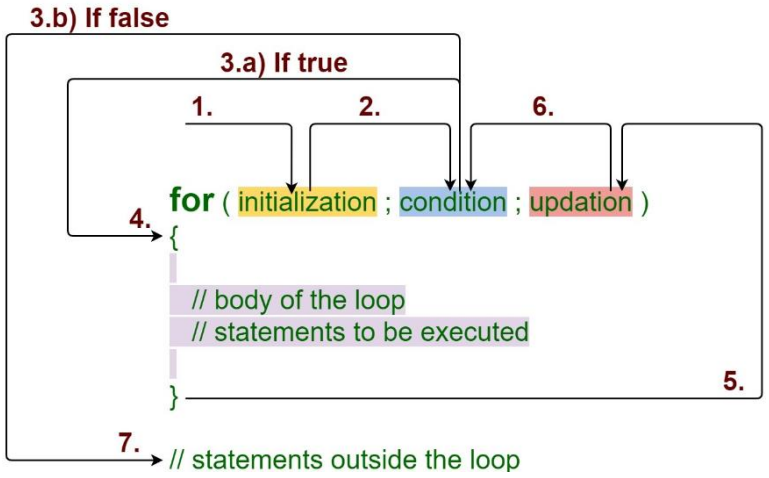
Loops

- Main components
  - Initialization.
  - Condition.
  - Statement(s) (What to do)
  - Update.

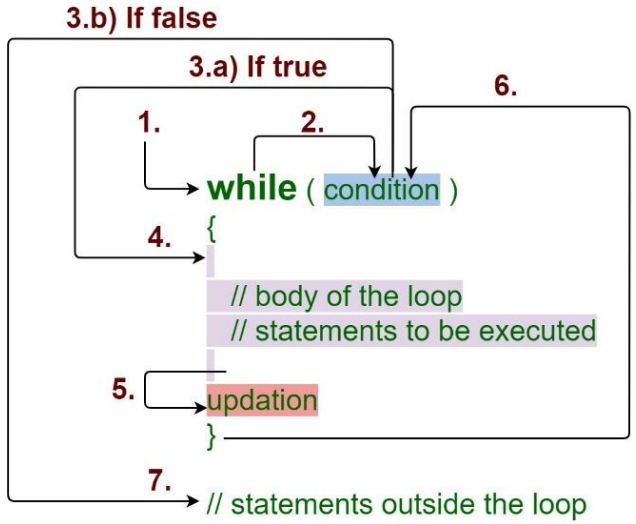


Loop types

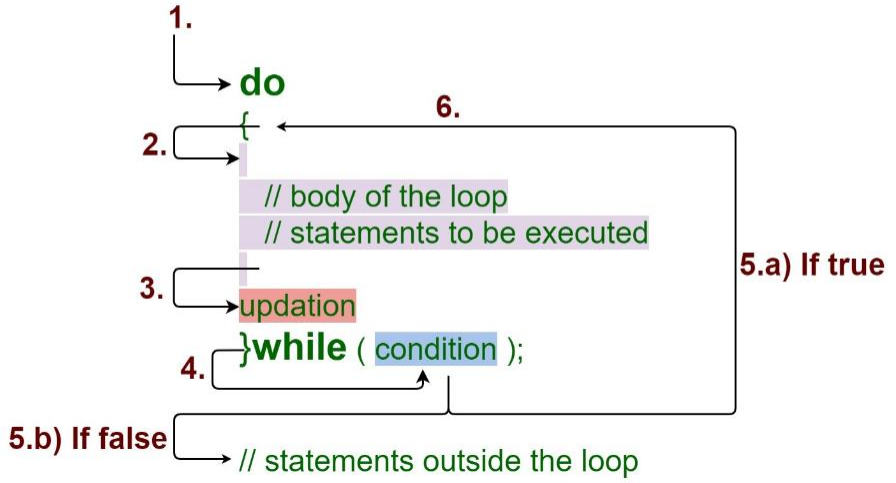
For Loop



While Loop



Do - While Loop

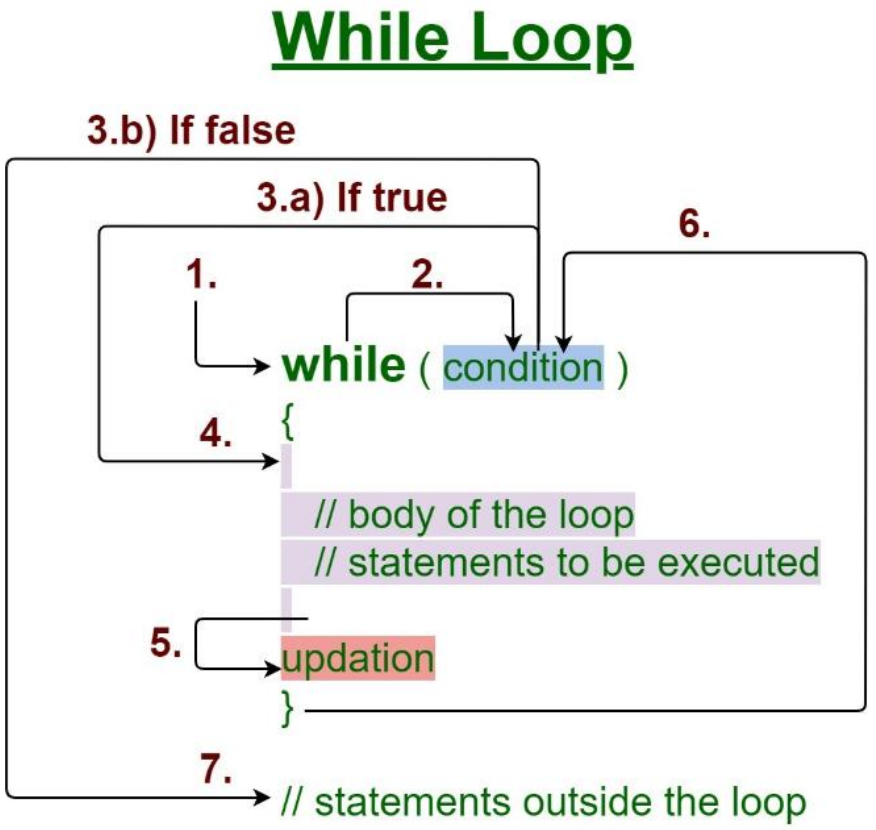


`while` Looping (Repetition) Structure

- The general form of the `while` statement is:

```
while (expression)
    statement
```

  `while` is a reserved word
- Statement can be simple or compound
- Expression acts as a decision maker and is usually a logical expression
- Statement is called the **body of the loop**
- The parentheses are part of the syntax

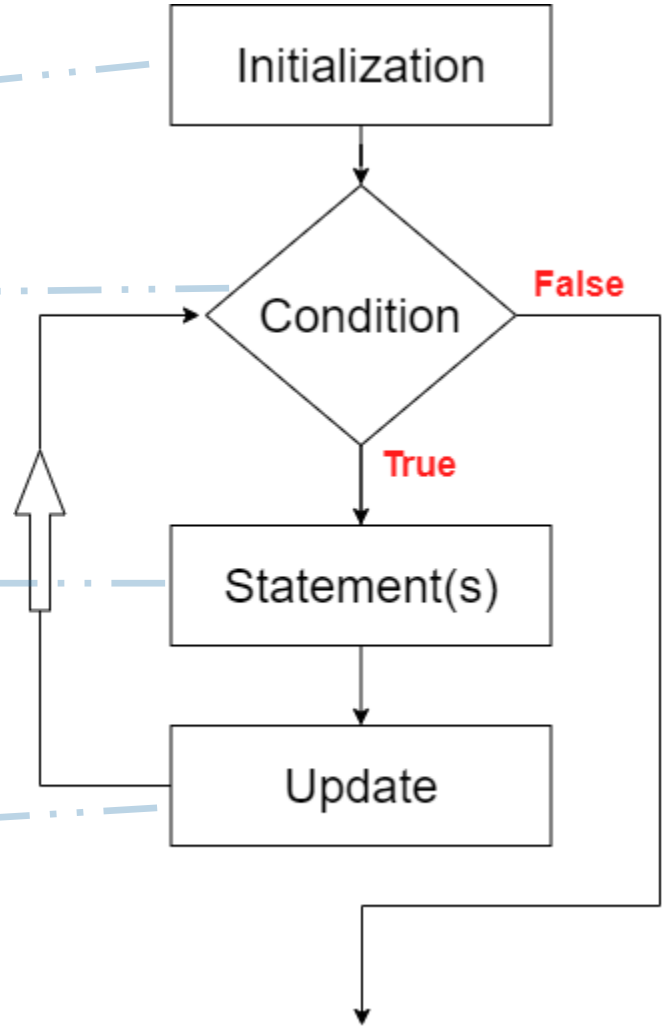


While loop

```
Initialization;
while (condition)
{
        statement_1;
        statement_2;
        statement_n;

        update;
}
```

body of the loop



Exercise_1: Print numbers between [1-100].

```
int main()
{
    int i = 1;
    while (i<=100)
    {
        cout<<i<<endl;
        i += 1;
    }
}
```

Exercise_2: Print numbers between [100-1].

```
int main()
{
    int i = 100;
    while (i>=1)
    {
        cout<<i<<endl;
        i -= 1;
    }
}
```

```
int main()
{
    int i = 100;
    while (i>=1)
    {
            cout<<i--<<endl;
     }
}
```

Exercise_3: Print “Hello World” 100 times.

```
int main()
{
    int i = 1;
    while (i<=100)
    {
        cout<<"Hello world!"<<endl;
        i += 1;
    }
}
```

What is the output of the following program ?

Consider the following C++ program segment:

```
i = 0;                              //Line 1

while (i <= 20)                     //Line 2
{
    cout << i << " ";               //Line 3
    i = i + 5;                      //Line 4
}

cout << endl;
```

Sample Run:

```
0 5 10 15 20
```

`for` Looping (Repetition) Structure

- The general form of the `for` statement is:

```
for (initial statement; loop condition; update statement)
    statement
```

- The `initial statement`, `loop condition`, and `update statement` are called `for` loop **control statements**
  - `initial statement` usually initializes a variable (called the `for` **loop control**, or `for` **indexed**, **variable**)
- In C++, `for` is a reserved word

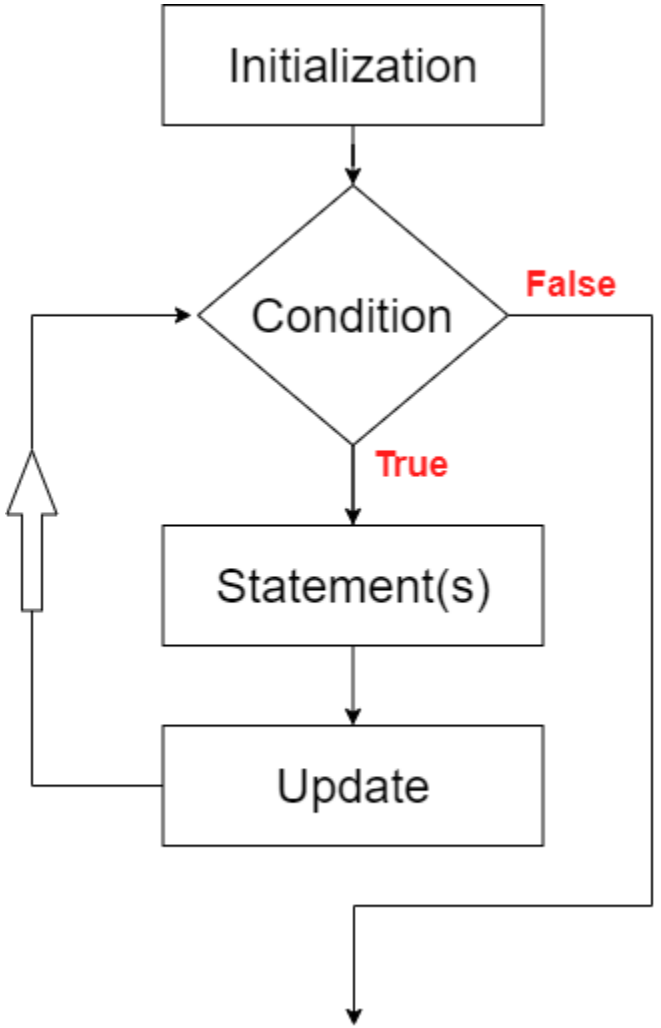
for loop

```
for ( Initialization; condition; update )
{
        statement_1;
        statement_2;

        statement_n;

}
```

body of the loop



Exercise_3: Print “Hello World” 100 times.

```
int main()
{
    int i = 1;
    while (i<=100)
    {
        cout<<"Hello world"<<endl;
        i += 1;
    }
}
```

```
int main()
{
    for (int i=1;i<=100;i++)
    {
        cout<<"Hello world"<<endl;
    }
}
```

Exercise_4: Print even and odd numbers between [1, 100].

```
int main()
{
   int i = 1;
   while (i<=100)
   {
      if (i%2==0)
         cout<<i++<<" even "<<endl;
      else
         cout<<i++<<" odd "<<endl;
    }
}
```

```
int main()
{
   for (int i=1;i<=100;i++)
    {
      if (i%2==0)
         cout<<i<<" even "<<endl;
      else
         cout<<i<<" odd "<<endl;
    }
}
```

Exercise_5: Print even numbers between [1, 100].

```
int main()
{
    int i = 0;
    while (i<=100)
    {
        cout<<i<<endl;
        i += 2;
    }
}
```

```
int main()
{
    for (int i = 0; i<=100; i+=2)
    while ()
    {
        cout<<i<<endl;
    }
}
```

Exercise_6: Print the factors of a given number.

```
int main()
{
   int i = 1, n;
   cin>>n;
   while (i<=n)
   {
      if (n%i==0)
          cout<<i++<<" is a factor of “
                        <<n<<endl;
    }
}
```

```
int main()
{
   int i = 1, n;
   cin>>n;
   for (int i=1; i<=n; i++)
   {
      if (n%i==0)
          cout<<i<<" is a factor of “
                        <<n<<endl;
   }
}
```

Exercise_7: Write a C++ program to calculate the sum of numbers from 1 to 100

```
int main()
{
  int i = 1, sum=0;
  while (i <= 100)
  {
    sum += i;
    i++;
  }
  cout << "\n The sum of numbers
    from 1 to 100 is: "<<sum << endl;
  return 0;
}
```

```
int main()
{
  int sum=0;
  for (int i = 1 ;i <= 100; i++;)
  {
    sum += i;
  }
  cout << "\n The sum of numbers
    from 1 to 100 is: "<<sum << endl;
  return 0;
}
```

Exercise_8: Write a C++ program to find Factorial of a given number

```
int main()
{
  int i = 1, factorial=1, n;
  cin>>n;
  while (i <= n)
  {
    factorial *=  i;
    i++;
  }
  cout << n <<“! = "<<factorial <<endl;
  return 0;
}
```

```
int main()
{
  int factorial = 1, n;
  cin>>n;
  for (int i = 1 ;i <= n; i++;)
  {
    factorial *=  i;
  }
   cout << n <<“! = "<<factorial<<endl;
  return 0;
}
```

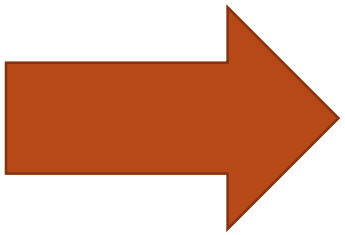
Bounce exercise

```
// Explain the output value of the second line
#include <iostream>
using namespace std;
int main()
{
    int a;
    a = 1500*1500;
    cout<< "first line\t"       <<a          <<endl; // 2250000
    cout<< "second line\t" <<a*1500<<endl; // -919967296
    return 0;
}
```

Quiz

- Print numbers which are divisible by 3, 5, or both in the interval between 1 and an input number.

The program output should be as follows



```
3 is divisible by 3
5 is divisible by 5
6 is divisible by 3
9 is divisible by 3
10 is divisible by 5
12 is divisible by 3
15 is divisible by 3 and 5
```

Answer of the quiz:

```
int main()
{
   int i=1;
   while (i<=100)
   {
      if (i%3 == 0 && i%5 == 0)
         cout<<i<<" is divisible by 3 and 5\n";
      else if (i%5==0)
         cout<<i<<" is divisible by 5\n";
      else if (i%3==0)
         cout<<i<<" is divisible by 3\n";
      i++;
   }
   return 0;
}
```

```
int main()
{
   for(int i =1;i<=100;i++)
   {
      if (i%3 == 0 && i%5 == 0)
         cout<<i<<" is divisible by 3 and 5\n";
      else if (i%5==0)
         cout<<i<<" is divisible by 5\n";
      else if (i%3==0)
         cout<<i<<" is divisible by 3\n";
   }
   return 0;
}
```