CSC103- Programming Fundamentals

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Chapter 5:
Nested Loops

Outline

- Nested loop
  - Nested while loop
  - Nested for loop

Nested Loops

- A nested loops consists 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 variable conditions are reevaluated.
  - All required iterations are performed again.

- Usually used to work with two dimensional arrays (later).

Nested Loops

- Nested loops consist of an **outer loop** with one or more **inner loops**.

- Example:

```
for (i=1;i<=100;i++){

        int x=10;

        for(j=1;j<=50;j++)

                cout<<"Welcome"<<x;

        cout<<endl;

}
```

Outer loop

Inner loop

- The above loop will run for 100*50 iterations.

Pattern of a Nested Loop (using for loop)

```
for  (initialize outer loop; outer loop condition; update )

{

        Outer loop processing

            for (        initialize inner loop; inner loop condition; update )

            {

                    inner loop processing

            }

        Outer loop processing

}
```

Example: Nested loop (counter-controlled [outer] + input-validation[inner])

```cpp
int main() {
    int i;
    bool gender;
    string name;
    int age;
    const int num_students = 3;

    for(i=0;i<num_students;i++)   {
        cout<<"Enter name:";
        cin>>name;
        cout<<"Enter gender:";
        cin>>gender;
        do      {
            cout<<"Enter age:";
            cin>>age;
        } while(age<=0);

        if(gender==true)
            cout<<"Mr. " << name << ", you are " << age << " years old";
        else
            cout<<"Ms. " << name << ", you are " << age << " years old";
    }
    return 0;
}
```
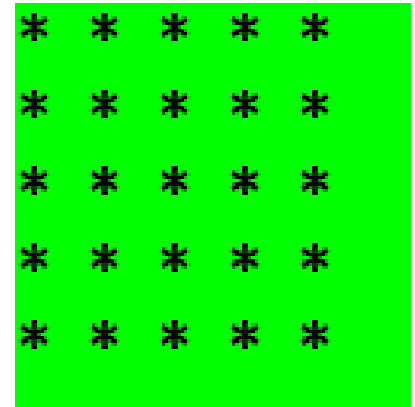
Examples: Using nested loops to draw asterisk figures (ASCII art)

Drawing figures can illustrate how nested loops work

Keep in mind the principle:
◦ outer loop controls number of lines,
◦ inner loop controls content of lines

Trace the following loop

```
int x, y;
for(x=0; x<5; x++)
{
        for(y=0; y<5; y++)
                cout<<"* ";
        cout<<endl;
}
```

OUTPUT???

```
* * * * *
* * * * *
* * * * *
* * * * *
* * * * *
------------------------
```

Inner for loop without brackets

OUTPUT:

```
int x, y;
for(x=0; x<5; x++)
{
    for(y=5; y>0; y--)
        cout<<"* ";
    cout << "\n";
}
```

Notice there are no brackets for inner loop.

```
* * * * *
* * * * *
* * * * *
* * * * *
* * * * *
------------------
```

Outer for loop without brackets

```
int x, y;
for(x=0; x<5; x++)
{
        for(y=5; y>0; y--)
            cout << "* ";
        cout << "\n";
}
```

What if outer loop brackets are also not there?

Outer for loop without brackets

```
int x, y;
for(x=0; x<5; x++)
        for(y=5; y>0; y--)
                cout << "* ";
cout << "\n";
```

Output

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

Outer for loop without brackets

```
int x, y;
for(x=0; x<5; x++)
      ;
for(y=5; y>0; y--)
      cout << "* ";
cout << "\n";
```
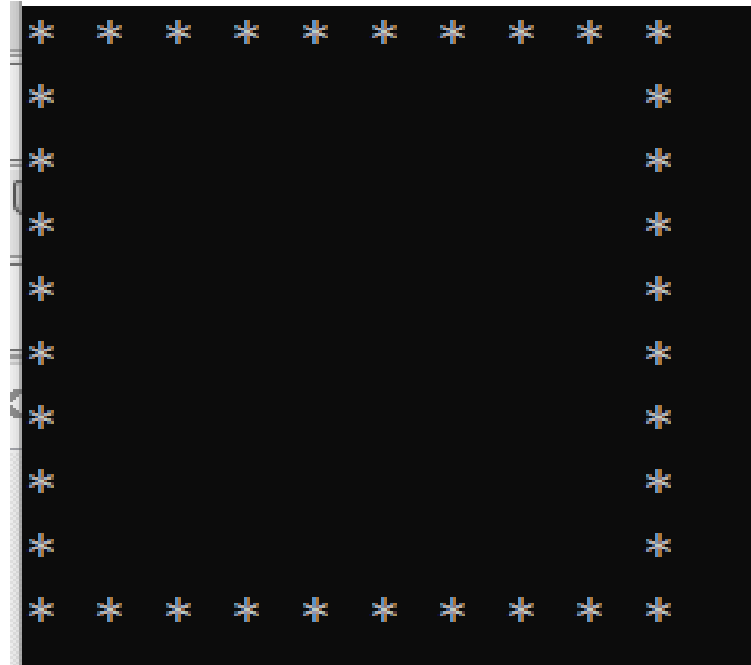
Output

Trace the following program

```
int main()
{
int i, j;
for(i=0;i<10;i++)
{
    for(j=0;j<10;j++)
    {
        if(i==0||i==9||j==0||j==9)
            cout<<"* ";
        else
            cout<<"  ";
    }
    cout<<endl;
}

    return 0;
}
```
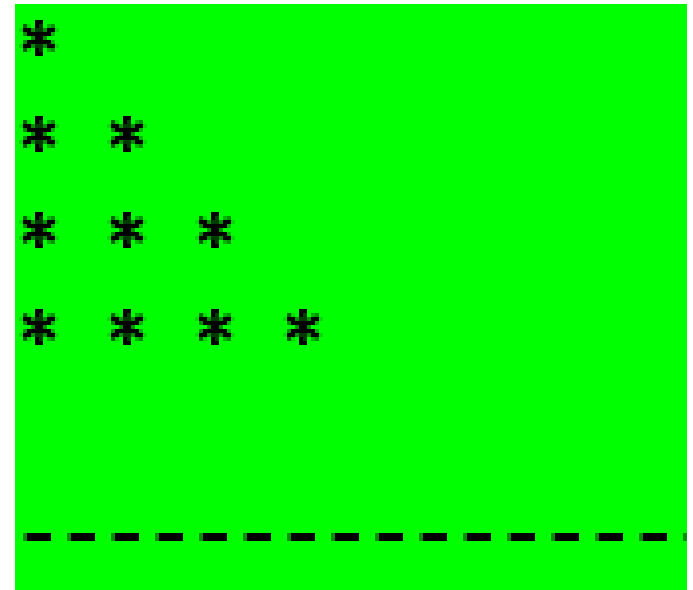
Output

Nested Loop example with dynamic condition

```
int x,y;
for (x=1; x<5; x++)
{
        for (y=1; y<=x; y++)
        {
                cout << "* ";
        }
        cout << "\n";
}
```

OUTPUT:

```
*
*  *
*  *  *
*  *  *  *
--------------------------------
```

Nested Loop example with dynamic initialization

```cpp
int x,y;
for (x=1; x<5; x++)
{
        for (y=x; y<5; y++)
        {
                cout <<  "*" ;
        }
        cout <<  "\n" ;
}
```

OUTPUT:

```
****

***

**

*
```

Trace the following loop

height = 4

x	y					z			
0	4	3	2	1	0	0			
1	4	3	2	1		0	1		
2	4	3	2			0	1	2	
3	4	3				0	1	2	3

```
int x,y,z,height;
cout<<"Enter Height: ";
cin>>height;
for (x=0; x<height; x++)
{
    for (y=height; y>x; y--)
     cout << " " ;
   for(z=0; z<=x; z++)
     cout<<"* ";
    cout <<  "\n" ;
}
```

Output???

```
Enter Height: 4
     *
    * *
   * * *
  * * * *
```

- y loop prints spaces
- z loop prints stars

Pattern of a Nested Loop (using while loop)

```
initialize outer loop

while  ( outer loop condition )

{

        Outer loop processing

        initialize inner loop

        while ( inner loop condition )

        {

                inner loop processing and update

        }

    Outer loop processing and update

}
```

What is the Output?

```
1.  /* This loop repeats 10000 times. outer loop: 100, inner
    loop: 100, total: 100*100=10000 */
2.  lcv1 = 0;
3.  sum = 0;
4.  while (lcv1 < 100)
5.  {
6.     lcv2 = 0;
7.     while (lcv2 < 100)
8.     {
9.        sum = sum + 1;
10.       lcv2++;
11.    }
12.    lcv1++;
13. }
14. cout << "Sum is %d\n" << sum;
```
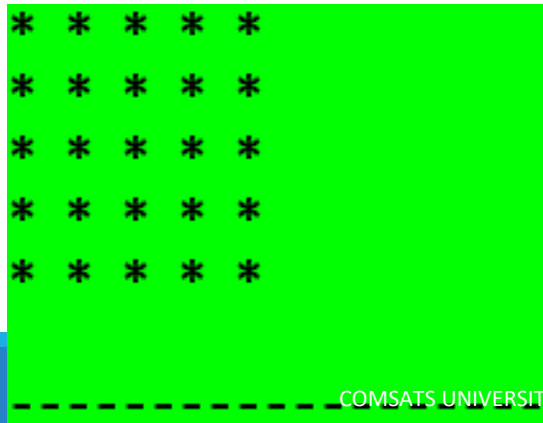
```
/* Output = */
Sum is 10000
```

Trace the following loop

```
int x, y;
for(x=0; x<5; x++)
{
        for(y=0; y<5; y++)
                cout << "* ";
        cout << "\n");
}
```

```
int x=0;
while(x<5)
{
        int y=0;
        while(y<5)
        {
                cout << "* ";
                y++;
        }
        cout << "\n";
        x++;
}
```

OUTPUT:

```
* * * * *
* * * * *
* * * * *
* * * * *
* * * * *
_ _ _ _ _ _ _ _ _ _
```

Exercise

Convert all the nested for loops example programs into nested while loops programs.

Consult the Topic of Nested loop from Text Book as well.