SSCM 1313
C++ COMPUTER PROGRAMMING

Chapter 3:
Loop and Branching

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Loop

Something that repeats.

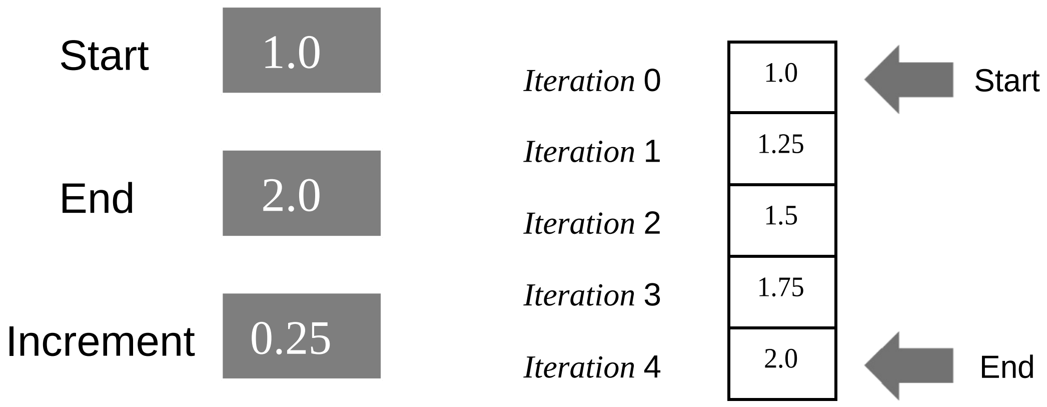


Figure 3.2. Iterations from 1.0 to 2.0 with an increment of 0.25.

Three types of loops in C++:

```
for   …
while   …
do   …   while
```

To end a loop:

break	*Terminates the loop and places the control at the statement immediately after the loop*
return	*Terminates the loop and ends the program immediately*

for loop

```
for   (Start; End; Increment)
{
      <Set of Statements >        Body
}
```

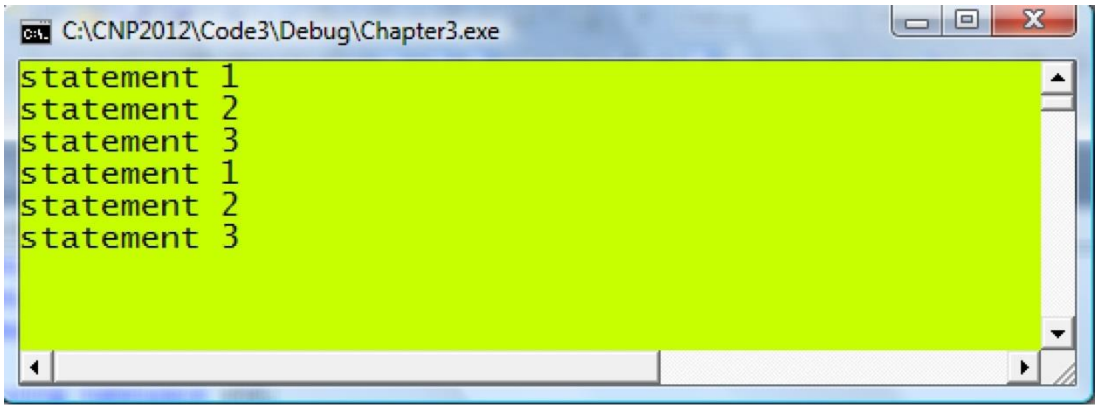
<u>Code 3A.cpp: for loop.</u>

```
#include <iostream>
#include <conio.h>
#define n 3

using namespace std;

void main()
{
   // this is not a loop
   int i=1;
   cout << "statement " << i++ << endl;
   cout << "statement " << i++ << endl;
   cout << "statement " << i << endl;

    // for  loop
   For (i=1;  i<=n;  i++)
       cout << "statement " << i << endl;
    getch();
}
```



```
statement 1
statement 2
statement 3
statement 1
statement 2
statement 3
```

Increment

`i++`	is `i=i+1`, or *the new value is the old one adds 1*,
`i--`	is `i=i-1`, or *the new value is the old one subtracts 1*,
`i+=3`	is `i=i+3`, or *the new value is the old one adds 3*,
`i-=3`	is `i=i-3`, or *the new value is the old one subtracts 3*,
`i+=0.5`	is `i=i+0.5`, or *the new value is the old one adds 0.5*.
`i*=0.5`	is `i=i*0.5`, or *the new value is the product of old one with 0.5.*
`i/=0.5`	is `i=i/0.5`, or *the new value is the old one divided by 0.5.*

```
for (i=1;i<=10;i+=2)
```
has five repeats, at `i`=1,3,5,7 and 9.

```
for (i=10;i>=1;i-=2)
```
has five repeats, at `i`=10,8,6,4 and 2.

```
For (i=1;i<=5;++i)
```
has four repeats, at `i=2,3,4` and 5.

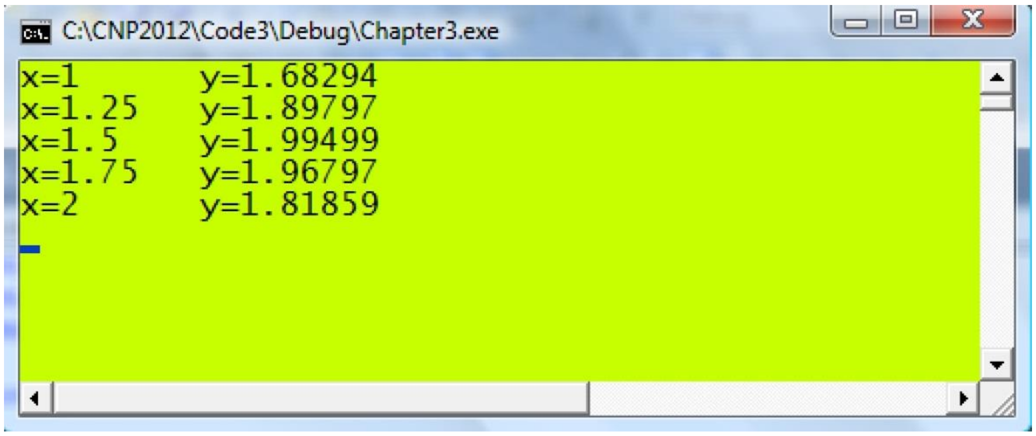
```
for (i=0;i<=1;i+=0.5)
```
has three repeats, at `i=0`, `0.5` and 1.

Code3B.cpp: for Solution to Figure 3.2

```
#include <iostream>
#include <iostream>
#include <conio.h>
#define f(x) (2*sin(x))

using namespace std;

void main()
{
       double x,y;
       for (x=1.0;  x<=2.0;  x+=.25)
       {
              y=f(x);
              cout  <<  "x="  <<  x  <<  "\t  y="  <<  y  <<  endl;
       }
       getch();
}
```



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```
x=1       y=1.68294
x=1.25    y=1.89797
x=1.5     y=1.99499
x=1.75    y=1.96797
x=2       y=1.81859
```

	i	*x*	*y*	*z*
Iteration 0	0	1.0	8.0	-5.0
Iteration 1	1	1.25	6.0	-2.25
Iteration 2	2	1.5	4.0	0.5
Iteration 3	3	1.75	2.0	3.25
Iteration 4	4	2.0	0.0	6.0

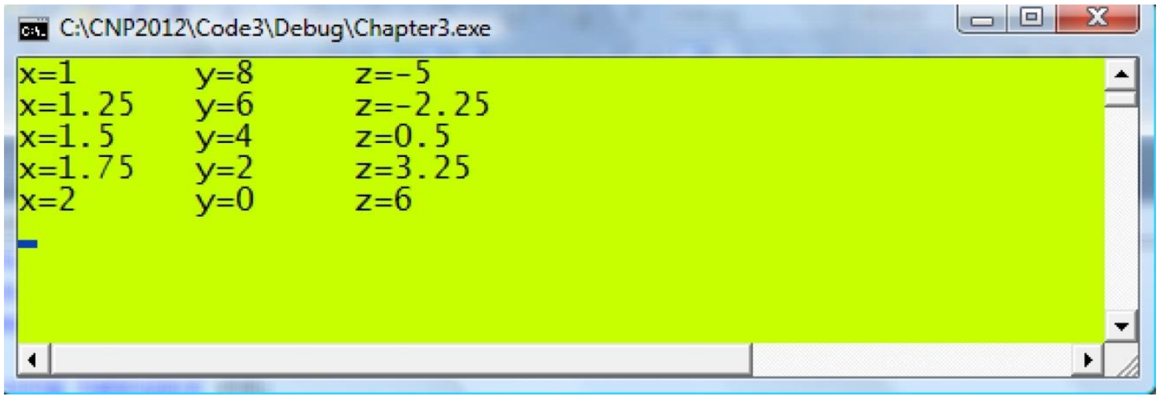
Figure 3.3. Five iterations in $z = f(x, y) = 3x - y$.

Code3C.cpp: Looping on a function.

```
#include <iostream>
#include <conio.h>
#define f(a,b)  ((double)(3*a-b))

using namespace std;

void main()
{
        int i;
        double x=1, y=8, z;
        for (i=0; i<=4; i++)
        {
                z=f(x,y);
                cout << "x=" << x << "\t y=" << y << "\t z=" << z << endl;
                x += 0.25;
                y -= 2;
        }
        getch();
}
```



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```
x=1        y=8       z=-5
x=1.25     y=6       z=-2.25
x=1.5      y=4       z=0.5
x=1.75     y=2       z=3.25
x=2        y=0       z=6
```

Looping with while

```
while   (End)
{
        <Set of Statements >    ]   Body
}
```

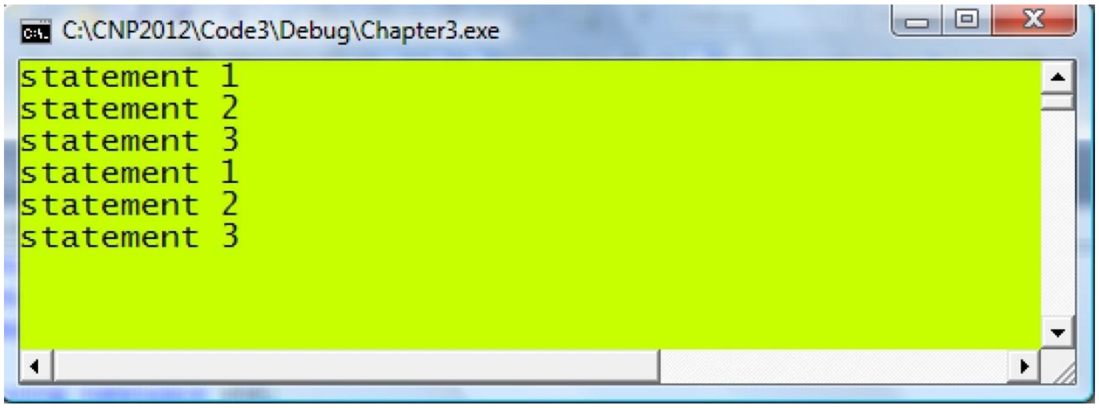
Code3D.cpp: while loop.

```
#include <iostream>
#include <conio.h> #define
n 3

using  namespace  std;

void  main()
{
       // this  is  not  a  loop  int
       i=1;
       cout << "statement " << i++ << endl; cout <<
       "statement  "  <<  i++  <<  endl;  cout  <<
       "statement " << i << endl;

       // while  loop
       i=1;
       while  (i<=n)
              cout << "statement " << i++ << endl;
       getch();
}
```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```
statement 1
statement 2
statement 3
statement 1
statement 2
statement 3
```

Infinite loop

```
while(1)
```

An infinite loop is practical in applications such as in controlling the user's input in a menu. An infinite loop will only stop if it encounters `break` or `return` which is placed through a conditional branching. An infinite loop is like driving in a roundabout where the driver can go on driving forever. An infinite loop will need to stop after some criteria has been fulfilled through `break` or `return`.

`Code3E.cpp` illustrates an infinite loop for asking the user to key in characters in the keyboard. The program will not stop, and will continue asking the user to type the characters until the user presses 'x', which terminates the program through `break`. In this program, a *conditional branching* is used to break the loop through

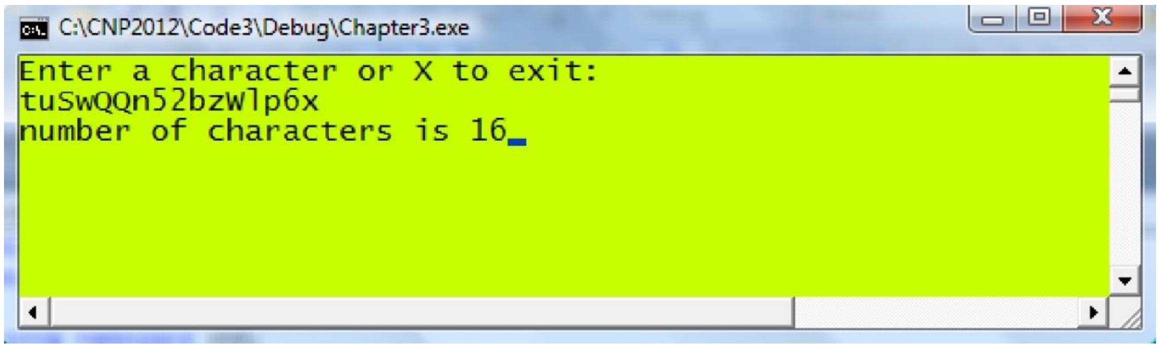
```
if (w=='x')
      break;
```

Code3E.cpp: Infinite loop.

```
#include <iostream>
#include <conio.h>

using namespace std;

void main()
{
       int count=0;
       char w;
       cout << "Enter a character or X to exit: " <<
       endl;
       while (1)
       {
              w=getche();
              count++;
              if (w=='x')
                  break;
       }
       cout << endl << "number of characters is " << count;
       getch();
}
```


C:\CNP2012\Code3\Debug\Chapter3.exe

```
Enter a character or X to exit:
tuSwQQn52bzWlp6x
number of characters is 16_
```

`getch()`	Read input from the keyboard.
return type	`int`
arguments	*`void`*
Prototype	`conio.h`
example	`char g;` `g=getch();` `//assigns g with the character from the keyboard.`

`getche()`	Read input from the keyboard.
return type	`int`
arguments	*`void`*
prototype	`conio.h`
example	`char g;` `g=getch();` `//assigns g with the character from the keyboard and displays it on the console.`

Looping with do…while

```
do
{
        <Set of Statements >     Body
} while (End);
```

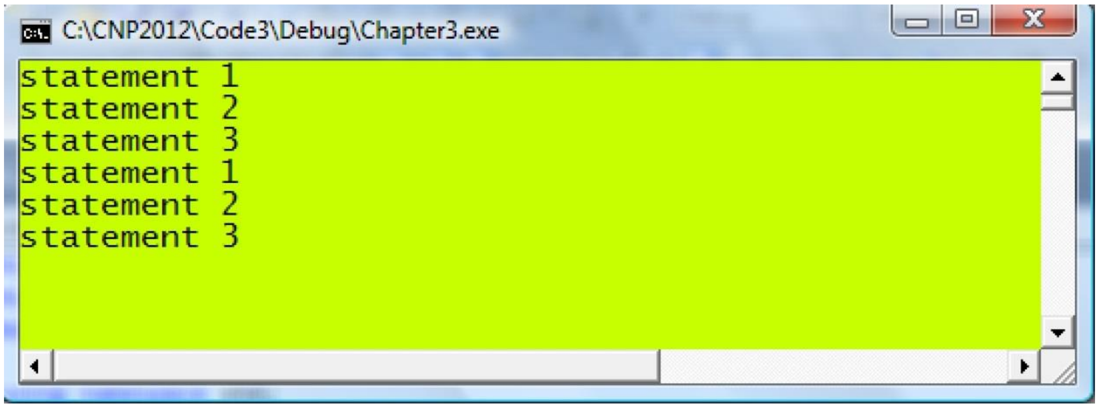
Code 3F.cpp: do…while loop.

```
#include
<iostream>
#include <conio.h>

using namespace std;

void main()
{
        int i=1;
        cout << "statement " << i++ << endl;
        cout << "statement " << i++ << endl;
        cout << "statement " << i << endl;

        i=1;
        do
        {
           cout << "statement " << i++ << endl;
        } while (i<=3);
        getch();
}
```


C:\CNP2012\Code3\Debug\Chapter3.exe

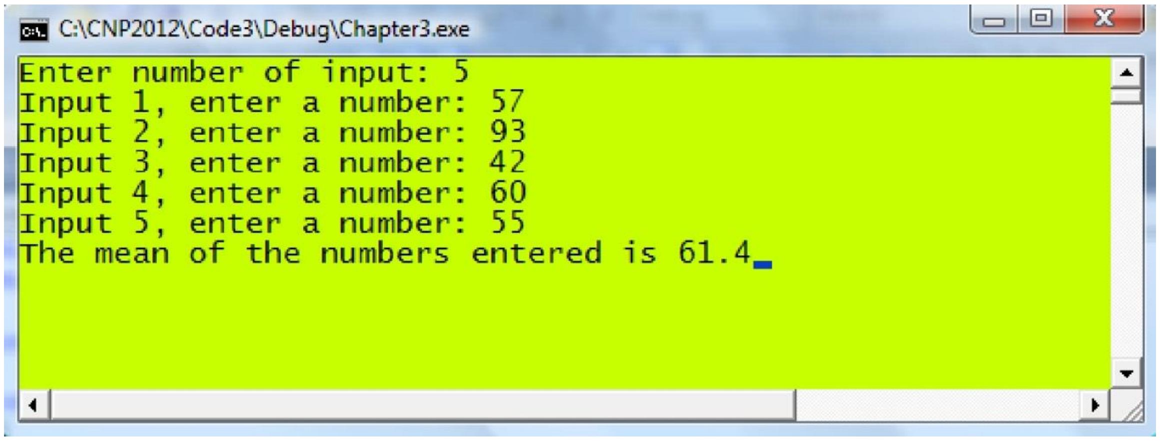
```
statement 1
statement 2
statement 3
statement 1
statement 2
statement 3
```

Code3G.cpp: Computing the mean of numbers.

```
#include<iostream>
#include
<conio.h>

using namespace std;

void main()
{
      int i,n;
      double x,  sum=0.0,  mean;
      cout << "Enter number of
      input: "; cin >> n;
      for (i=1;i<=n;i++)
      {
            cout << "Input " << i << ", enter a number: ";
            cin >> x;
            sum +=  x;
      }
      mean=(double)sum/n;
      cout << "The mean of the numbers entered is " << mean;
      getch();
}
```



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```
Enter number of input: 5
Input 1, enter a number: 57
Input 2, enter a number: 93
Input 3, enter a number: 42
Input 4, enter a number: 60
Input 5, enter a number: 55
The mean of the numbers entered is 61.4_
```

Code3H.cpp: Evaluating functions.

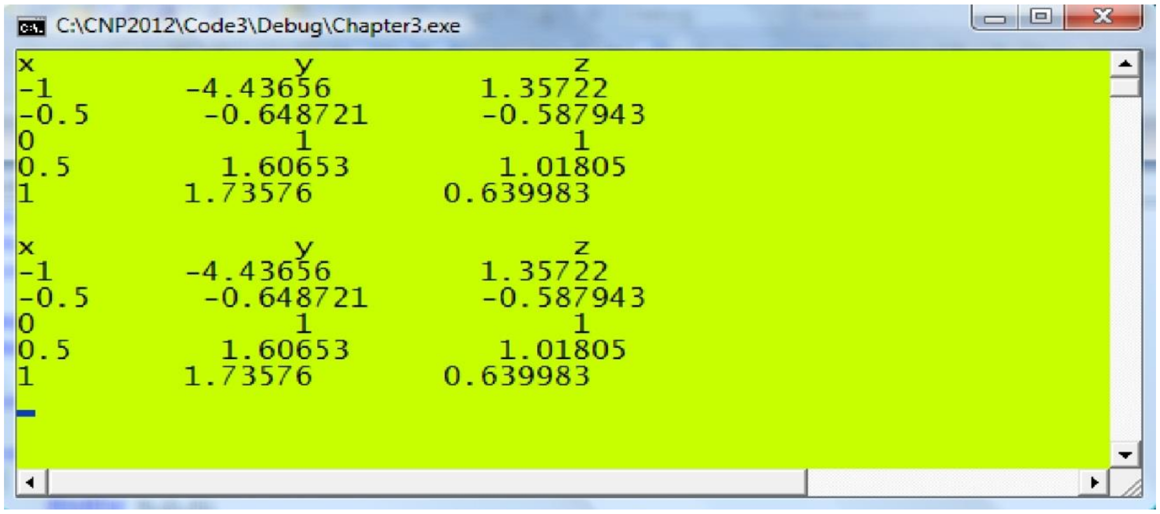
```
#include <iostream>
#include <iomanip>
#define f(t) (1+2*t*exp(-t))
#define g(u,v) (1+u*v*sin(u*v))

using namespace std;

void main()
{
       double x,y,z;

       // iterations  using  for
       cout << "x" << setw(15) << "y" << setw(15) << "z" << endl;
       for (x=-1; x<=1; x+=0.5)
       {
              y=f(x);
              z=y/g(x,y);
              cout  <<  x  <<  setw(15)  <<  y  <<  setw(15)  <<  z  <<  endl;
       }
       Cout << endl;

       // iterations  using  while
       cout << "x" << setw(15) << "y" << setw(15) << "z" << endl;
       x=-1;
       while (x<=1)
       {
              y=f(x);
              z=y/g(x,y);
              cout << x << setw(15) << y << setw(15) << z << endl;
              x += 0.5;
       }
       cin.get();
}
```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```
x              y              z
-1       -4.43656        1.35722
-0.5    -0.648721      -0.587943
0              1              1
0.5      1.60653        1.01805
1       1.73576       0.639983

x              y              z
-1       -4.43656        1.35722
-0.5    -0.648721      -0.587943
0              1              1
0.5      1.60653        1.01805
1       1.73576       0.639983
```

Nested Loop

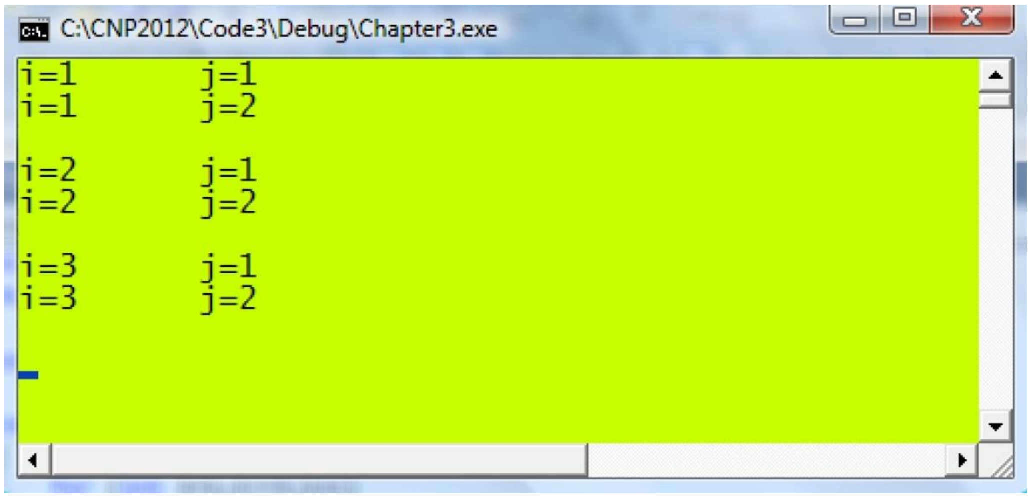
- a loop within another loop

Code3I.cpp: Nested loop.

```
#include <iostream>
#include <conio.h>

using namespace std;

void main()
{
      for (int i=1;i<=3;i++)
      {
            for (int j=1;j<=2;j++)
                 cout << "i=" << i << "\t j=" << j << endl;
            cout << endl;
      }
      getch();
}
```



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```
i=1        j=1
i=1        j=2

i=2        j=1
i=2        j=2

i=3        j=1
i=3        j=2
```

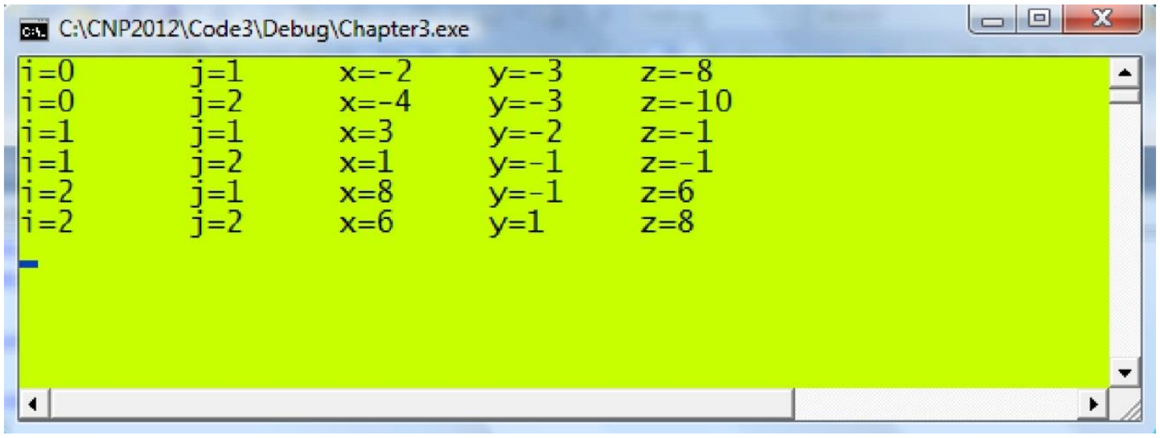
```
for  (i=0;i<=2;i++)
    for  (j=1;j<=2;j++)
    {
        x=5*i-2*j;
        y=i*j-3;
        z=x+2*y;

    }
```

	i	*j*	*x*	*y*	*z*	
Iteration 0	0	1	-2	-3	-8	Start
Iteration 1	0	2	-4	-3	-10	
Iteration 2	1	1	3	-2	-1	
Iteration 3	1	2	1	-1	-1	
Iteration 4	2	1	8	-1	6	
Iteration 5	2	2	6	1	8	End

Figure 3.4. Six iterations in the nested loop.

Code3J.cpp: Iterations on a nested loop.

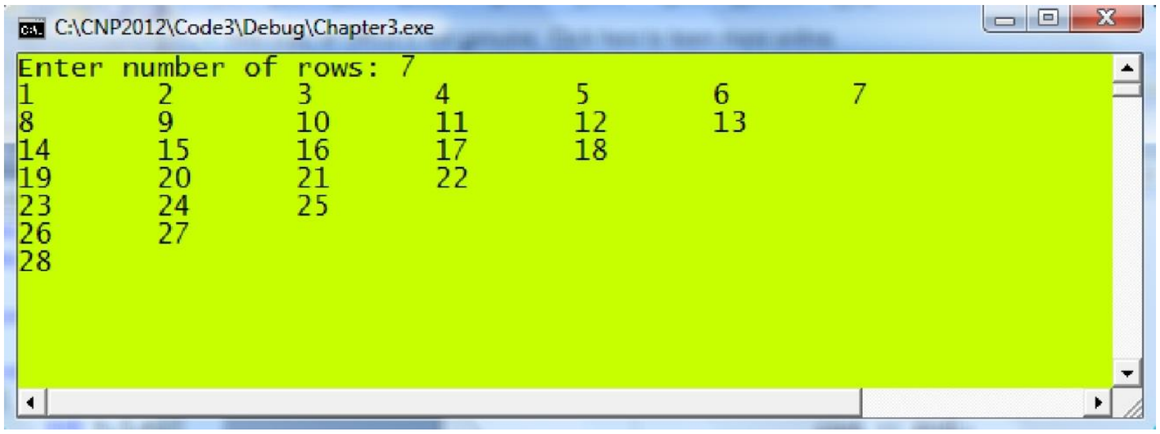
```
#include <iostream>
#include <conio.h>

using namespace std;

void main()
{
      int i,j,x,y,z;
      for (i=0;  i<=2;  i++)
            for (j=1;  j<=2;  j++)
            {
                x=5*i-2*j; y=i*j-3; z=x+2*y;
                cout <<"i="<<i<<"\t  j="<<j;
                cout <<"\t x="<< x << "\t  y="<< y <<"\t  z="
                     << z << endl;
            }
      getch();
}
```


C:\CNP2012\Code3\Debug\Chapter3.exe

```
i=0        j=1       x=-2      y=-3      z=-8
i=0        j=2       x=-4      y=-3      z=-10
i=1        j=1       x=3       y=-2      z=-1
i=1        j=2       x=1       y=-1      z=-1
i=2        j=1       x=8       y=-1      z=6
i=2        j=2       x=6       y=1       z=8
```

Code3K.cpp: Displaying data in columns.

```
#include <iostream>
#include <conio.h>

using namespace std;

void main()
{
	int i,j,m,k=1;
	cout << "Enter number of rows:"; cin >> m;
	for (i=1;i<=m;i++)
	{
		for (j=i;j<=m;j++)
			cout << k++ << "\t";
		cout << endl;
	}
	getch();
}
```



```
Enter number of rows: 7
1       2       3       4       5       6       7
8       9       10      11      12      13
14      15      16      17      18
19      20      21      22
23      24      25
26      27
28
```

Conditional Branching

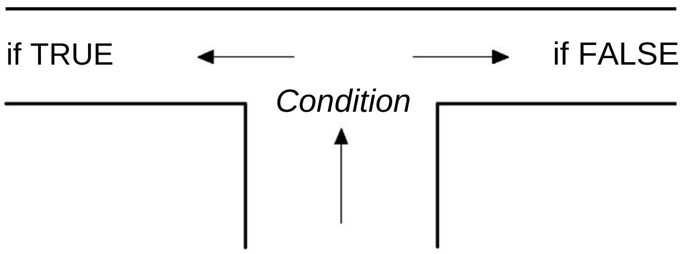
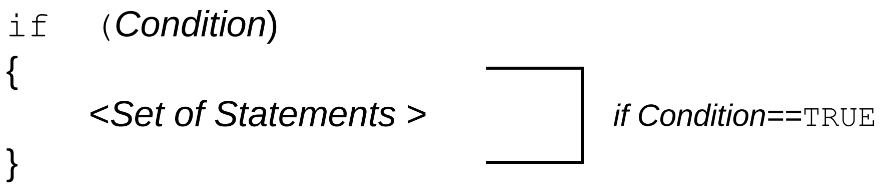


Figure 3.5. The `if` roadmap.

The `if` directive has a body of statements enclosed in the { } brackets according to the following format:



Condition in the above directives refers to a logical expression which returns either `TRUE` (1) or `FALSE` (0). For example, if `x=5`, then

```
if  (x>5)  returns  FALSE,

if  (x>=5)  returns  TRUE,

if  (x==5)  returns  TRUE,

if  (x<5)  returns  FALSE,

if  (x<=5)  returns  TRUE.
```

Please note

`if (x=5)` is not a conditional test,

`if (x==5)` is the right way for testing if `x=5`.

An expression can also include two or more conditions. This is possible through the Boolean relationships given by AND and OR. Their corresponding representations in C++ are given as follows:

AND is represented as &&,

OR is represented as ||

Both AND and OR require two tokens or expressions, one on the left and another on the right of the operator. The AND expression returns true if only both tokens on the left and right return TRUE. In contrast, the OR expression returns TRUE if one or both tokens agree. For example, the following relationships checks if x is a number either greater than 5 or less than -5:

```
if (x<-5  ||  x>5)
```

While, the following relationship performs a check to see if x is a number inside the interval given by $-5 \le x \le 5$:

```
if (x>=-5  &&  x<=5)
if   (Condition)
{
      <Set of Statements >    if Condition==TRUE
}
else
{
      <Set of Statements >    if Condition==FALSE
}
```

```
((Condition)?  Statement 1:  Statement 2);
               TRUE          FALSE
```

In the above format, the control flows to *Statement* 1 if *Condition* returns `TRUE`, and to *Statement* 2 if *Condition* returns `FALSE`. For example,

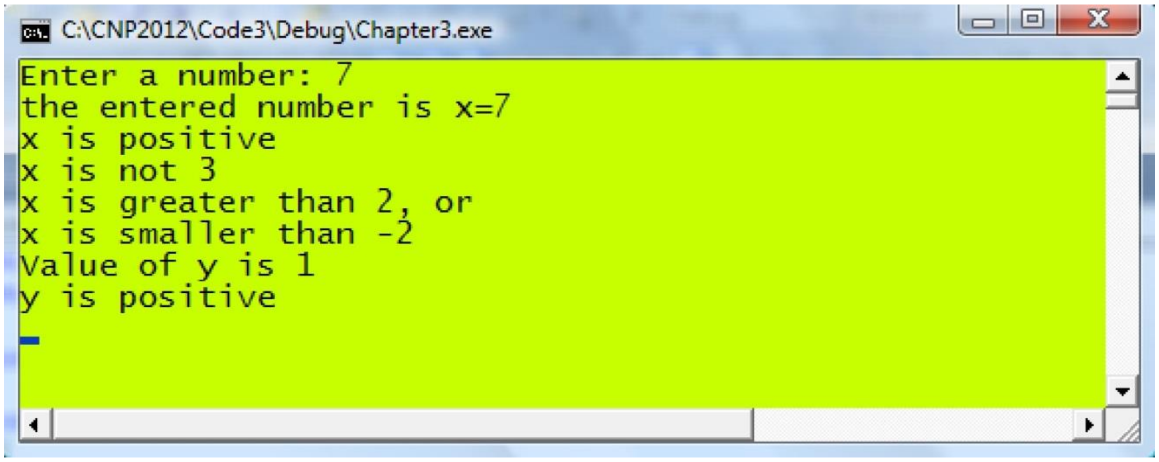
```
y=((x<5)?x*x:2x-1);
```

assigns `y=x*x` if `x<5`, otherwise `y=2*x-1`. This statement is similar to

```
if (x<5)
      y=x*x;
else
      y=2x-1;
```

Code3L.cpp: Testing a number.

```
#include <iostream>
#include <conio.h>

using namespace std;

void main()
{
	int x,y;
	cout << "Enter a number:";
	cin >> x;
	cout << "the entered number is x=" << x << endl;
	if (x>0)
		cout  <<  "x  is  positive"  <<  endl;
	else
		cout << "x is negative" << endl;

	if (x==0)
		cout << "x is zero" <<endl;
	if (x!=3)
		cout << "x is not 3" << endl;
	if (x>0 && x<=5)
		cout << "x is greater than 0 but less than or equal to 5" << endl;
	if (x<-2 || x>2)
	{
		cout << "x is greater than 2, or " << endl;
		cout << "x is smaller than -2" << endl;
	}

	y=((x>0)?1:-1);
	cout  <<  "Value  of  y  is  "  <<  y  <<  endl;

	bool a;
	a=((y>0)?1:0);
	if (a)
		cout  <<  "y  is  positive"  <<  endl;
	else
		cout << "y is negative" <<endl;
	getch();
}
```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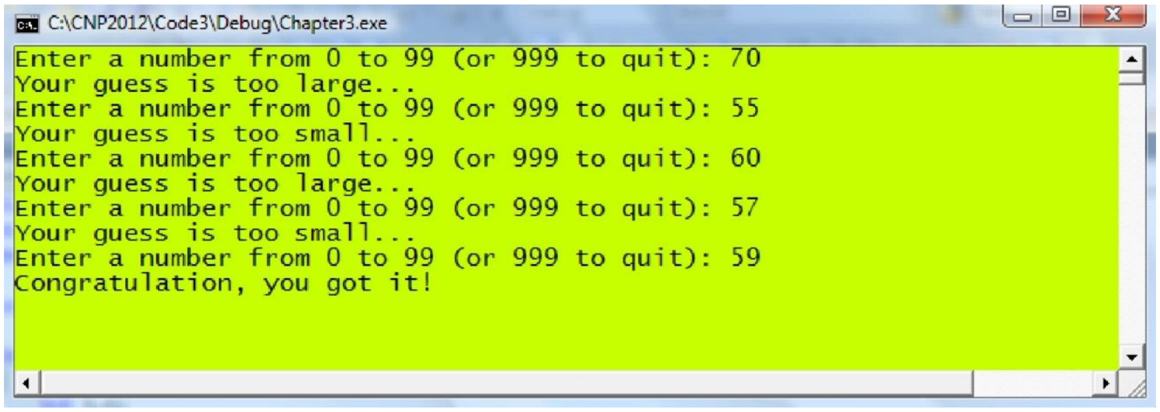
```
Enter a number: 7
the entered number is x=7
x is positive
x is not 3
x is greater than 2, or
x is smaller than -2
Value of y is 1
y is positive
```

Code3M.cpp: Guessing a number.

```
#include <iostream>
#include <conio.h>
#define N 59

using namespace std;

void main()
{
        int i,n;
        while (1)
        {
                cout << "Enter a number from 0 to 99 (or 999 to quit): ";
                cin >> n;
                if (n==999)
                        break;
                if  (n==N)
                {
                        cout << "Congratulation, you got it!" << endl;
                        break;
                }
                if  (n>N)
                        cout << "Your guess is too large..." << endl;
                if (n<N)
                        cout  <<  "Your  guess  is  too  small..."  << endl;
        }
        getch();
}
```



```
C:\CNP2012\Code3\Debug\Chapter3.exe
Enter a number from 0 to 99 (or 999 to quit): 70
Your guess is too large...
Enter a number from 0 to 99 (or 999 to quit): 55
Your guess is too small...
Enter a number from 0 to 99 (or 999 to quit): 60
Your guess is too large...
Enter a number from 0 to 99 (or 999 to quit): 57
Your guess is too small...
Enter a number from 0 to 99 (or 999 to quit): 59
Congratulation, you got it!
```

Multiple Branching with `switch`

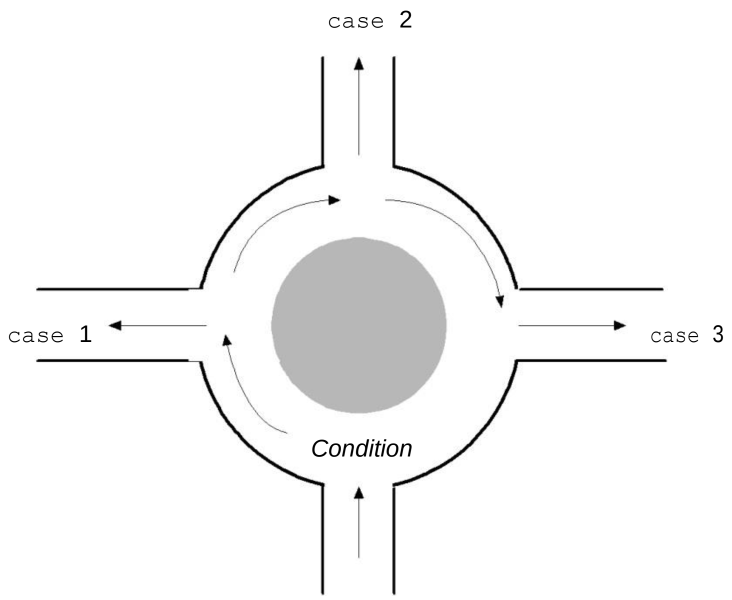


Figure 3.6. The `switch` roadmap.

```
switch   (variable)
{
      case   var1:
             <Body1>                    if  variable=var1
             break;
      case   var2:
             <Body2>                    if  variable=var1
             break;
         .
         .
         .
      default:
             <BodyDefault>              if  variable is not
             break;                     any of the above
}
```

```
char g='b';
int x=5,y;
switch (g)
{
      case  'a':
            y = 3*x+1;
            break;
      case  'b':
            y  =  3*x-1;
            break;
}
```

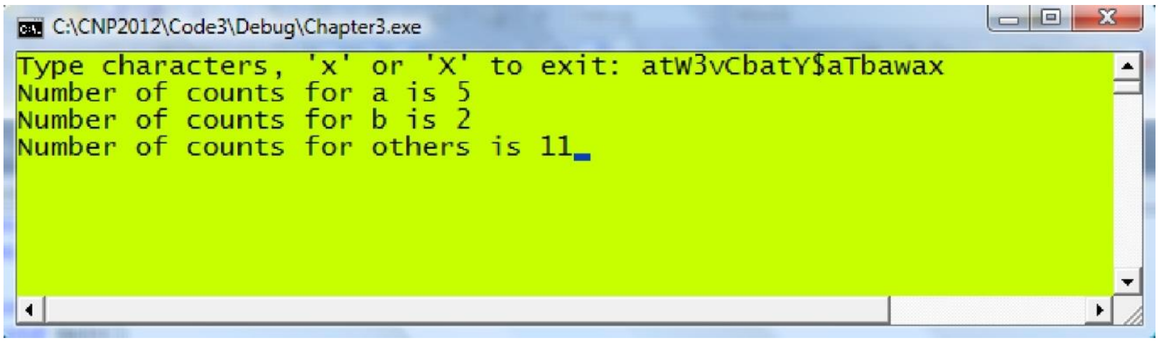
```
case  'x':
case  'X':
    y  =  3*x-1;
       break;
```

Code3N.cpp: Multiple branching with switch.

```
#include <iostream>
#include <conio.h>

using namespace std;

void main()
{
	int qa=0,qb=0,qd=0;
	char q;
	cout << "Type characters, 'x' or 'X' to exit: ";
	while (1)
	{
		q=getche();
		if (q=='x' || q=='X')
			break;
		switch  (q)
		{
			case 'a': qa++;
				break;
			case 'b': qb++;
				break;
			default: qd++;
				break;
		}
	}
	cout << endl << "Number of counts for a is " << qa << endl;
	cout << "Number of counts for b is " << qb << endl;
	cout << "Number of counts for others is " << qd+1;
	getch();
}
```



```
Type characters, 'x' or 'X' to exit: atW3vCbatY$aTbawax
Number of counts for a is 5
Number of counts for b is 2
Number of counts for others is 11_
```

MAIN REFERENCE:

Shaharuddin Salleh (2012), C++ Numerical Programming.