Fundamentals of Programming with C Language

PROGRAM CONTROL STATEMENTS

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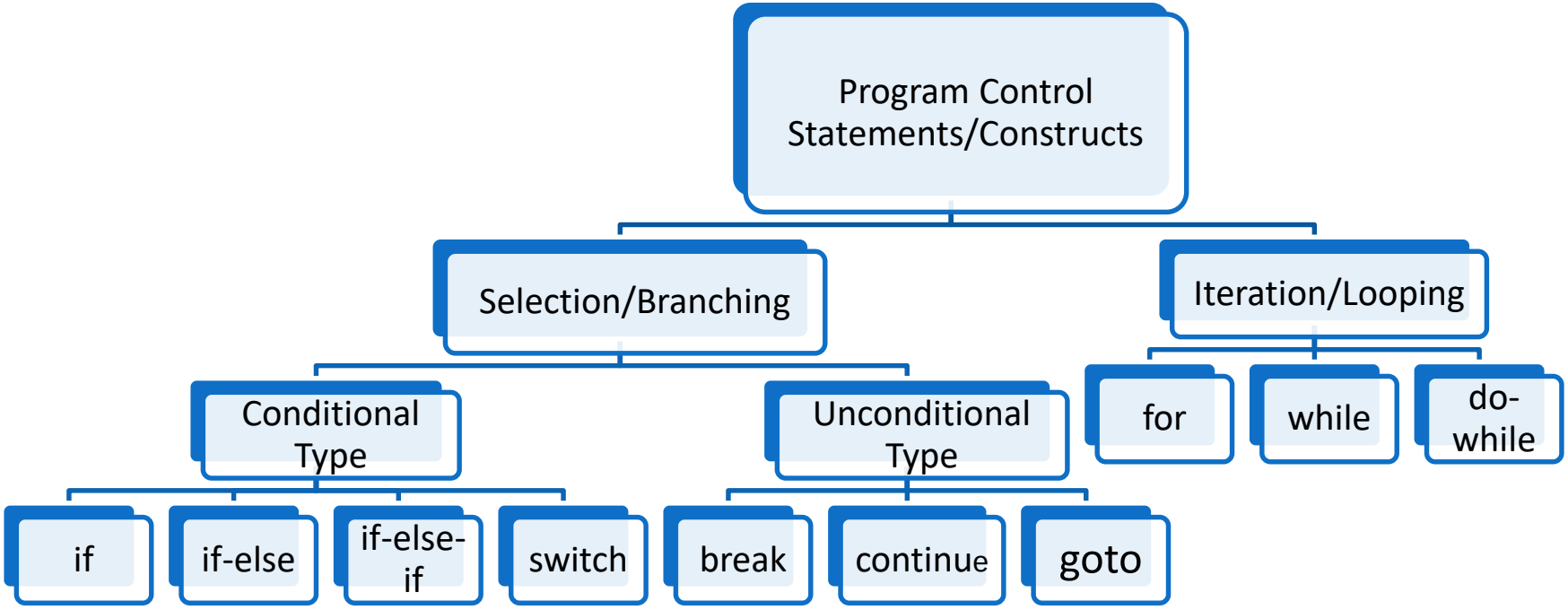
PROGRAM CONTROL STATEMENTS /CONSTRUCTS IN C

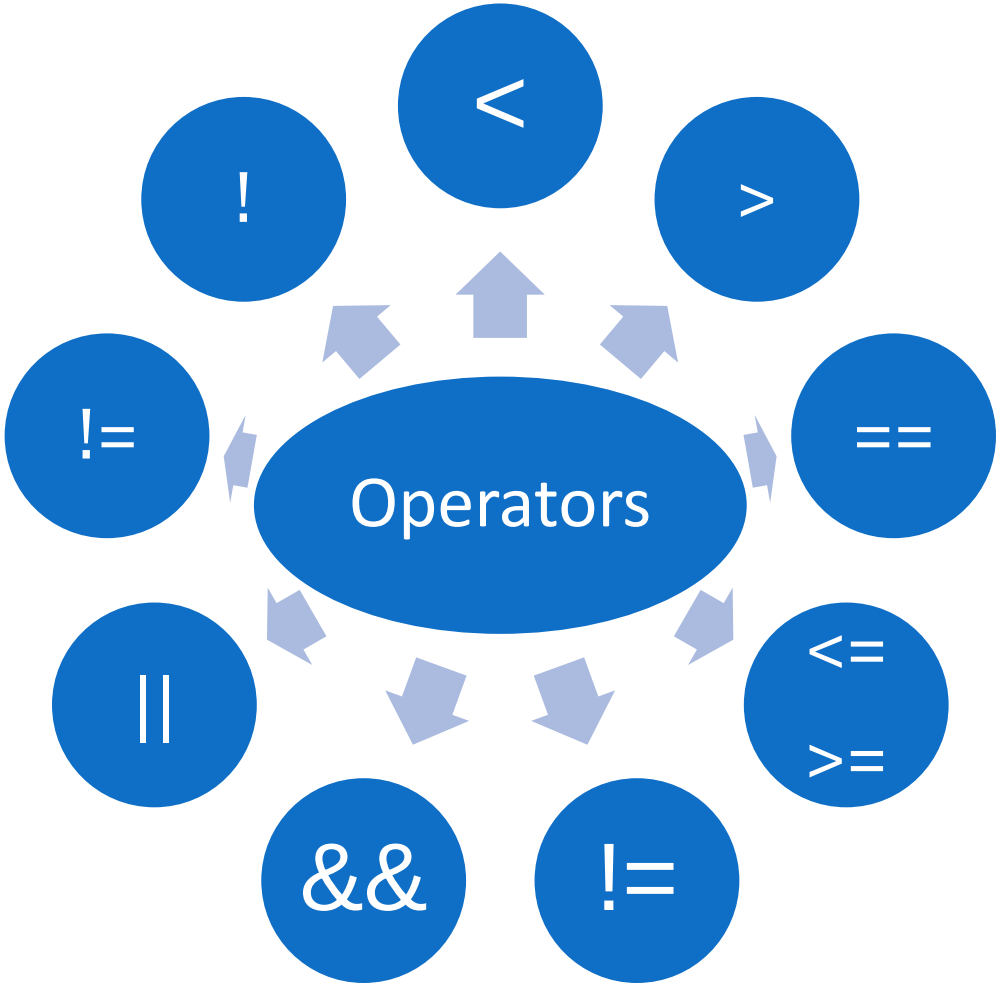


Program Control: Control Statements

Used for controlling the program execution flow. 3 groups are available:

- Selection/Conditional,
- Iteration/repetition/looping and
- Branching.

OPERATORS



RELATIONAL OPERATORS

To Specify	Symbol Used
less than	<
greater than	>
less than or equal to greater than or equal to	<= >=

Equality and Logical Operators

To Specify	Symbol Used
Equal to	==
Not equal to	!=
Logical AND	&&
Logical OR	||
Negation	!

C PROGRAM EXECUTION

- Program begins execution at the `main()` function.
- Statements within the `main()` function are then executed from top-down style, line-by-line.
- However, this order is rarely encountered in real C program.
- The order of the execution within the `main()` body may be branched.
- Changing the order in which statements are executed is called program control.
- Accomplished by using program control statements.
- So we can control the program flows.

TYPES OF PROGRAM CONTROLS

- There are three types of program controls:
  1. **Sequence** control structure.
  2. **Selection/Conditional** control structures such as `if`, `if-else`, nested `if`, `if-if-else`, `if-else-if` and `switch-case-break`.
  3. **Repetition** (loop) such as `for`, `while` and `do-while`.
- Certain **C functions** and **keywords** also can be used to control the program flows. E.g: continue, goto, break, exit(), system(), …

PROGRAM CONTROL

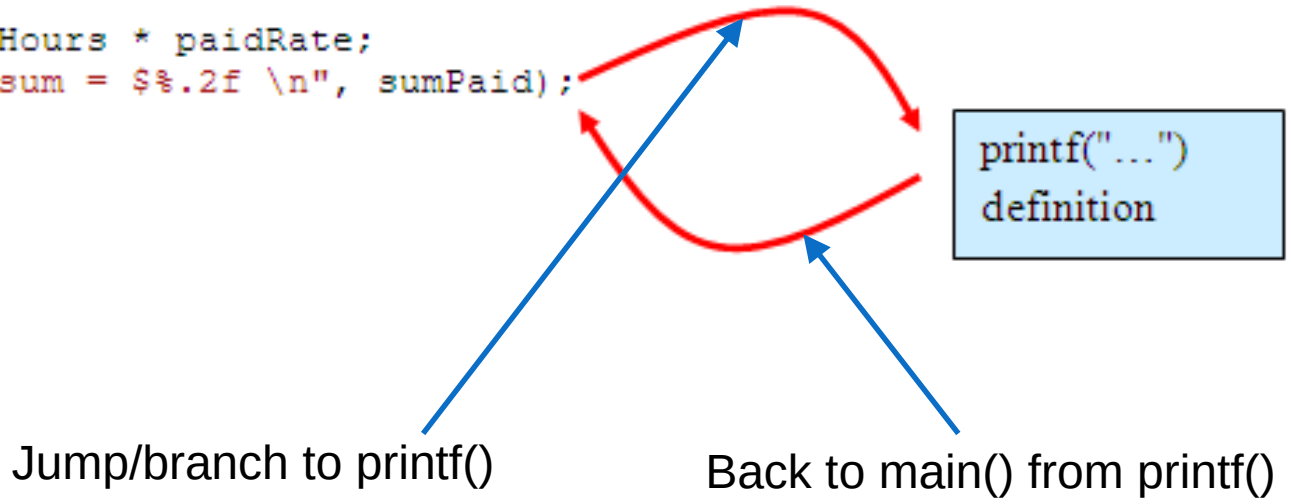
- Take a look at the following example

```c
#include <stdio.h> // put stdio.h file here

int main(void)
{
    float paidRate = 5.0, sumPaid, paidHours = 25;

    sumPaid = paidHours * paidRate;
    printf("Paid  sum = $%.2f \n", sumPaid);

    return 0;
}
```



PROGRAM CONTROL

`float paidRate = 5.0, sumPaid, paidHours = 25;`	S1
`sumPaid = paidHours * paidRate;`	S2
`printf("Paid  sum = $%.2f \n", sumPaid);`	S3
`return 0;`	S4

- One entry point and one exit point.
- Conceptually, a control structure like this means a sequence execution.

PROGRAM CONTROL: Selection Control Structure

- Program need to select from the options given for execution.
- At least 2 options, can be more than 2.
- Option selected based on the *condition* evaluation result: `TRUE` or `FALSE`.

SELECTION: if, if-else, if-else-if

- **if condition**
- Starting from the most basic if syntax,

`if (condition)`	`if (condition)`
`statement;`	`{ statements;}`
`next_statement;`	`next_statement;`

1. `(condition)` is evaluated.
2. If `TRUE` (non-zero) the `statement` is executed.
3. If `FALSE` (zero) the `next_statement` following the `if` statement block is executed.
4. So, during the execution, based on some condition, some codes were skipped.

SELECTION: if condition

For example:

```
if (hours > 70)
    hours = hours + 100;
printf("Less hours, no bonus!\n");
```

- If `hours` is less than or equal to 70, its value will remain unchanged and the `printf()` will be executed.
- If it exceeds 70, its value will be increased by 100.

```
if(jobCode == '1')
{
    carAllowance = 100.00;
    housingAllowance = 500.00;
    entertainmentAllowance = 300.00;
}
printf("Not qualified for car, housing and entertainment allowances!");
```

The three statements enclosed in the curly braces { } will only be executed if `jobCode` is equal to '1', else the `printf()` will be executed

SELECTION: if-else condition

`if (condition)`	`if (condition)`
`statement_1;`	`{ a block of statements;}`
`else`	`else`
`statement_2;`	`{ a block of statements;}`
`next_statement;`	`next_statement;`

Explanation:

1. The `(condition)` is evaluated.
2. If it evaluates to non-zero (TRUE), `statement_1` is executed, otherwise, if it evaluates to zero (FALSE), `statement_2` is executed.
3. They are mutually exclusive, meaning, either `statement_1` is executed or `statement_2`, but not both.
4. `statements_1` and `statements_2` can be a block of codes and must be put in curly braces.

SELECTION: if-else condition

For example:

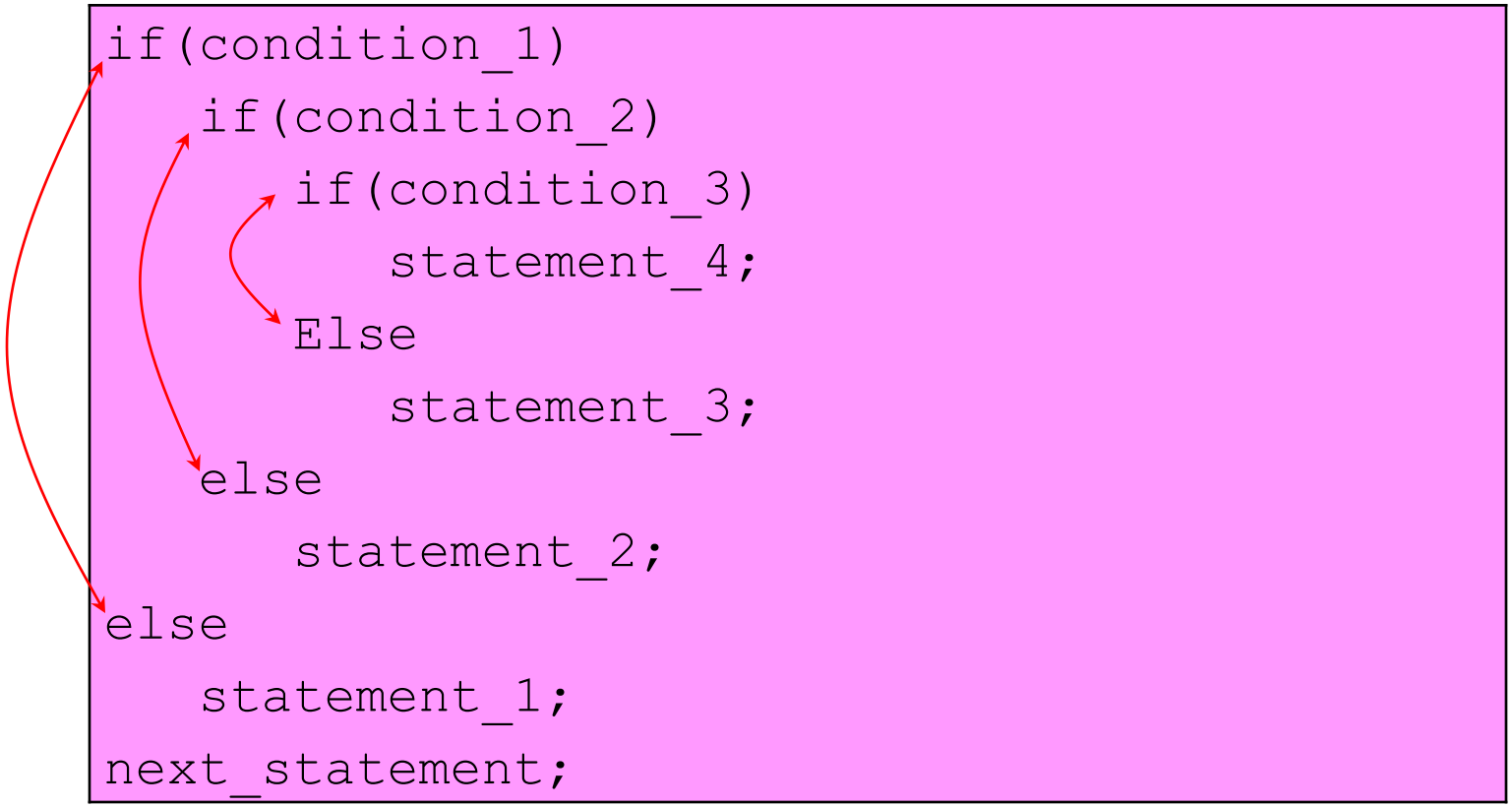
```
if(myCode == '1')
   rate = 7.20;
else
   rate = 12.50;
```

If `myCode` is *equal* to '1', the `rate` is 7.20 else, if `myCode` is *not equal* to '1' the `rate` is 12.50.

Equal/not equal (=) is not a value comparison, but a character comparison!

SELECTION: if-if-else

- The if-else constructs can be nested (placed one within another) to any depth.
- General forms: if-if-else and if-else-if.
- The if-if-else constructs has the following form (3 level of depth example),



```
if(condition_1)
    if(condition_2)
        if(condition_3)
            statement_4;
        Else
            statement_3;
    else
        statement_2;
else
    statement_1;
next_statement;
```

SELECTION: if-if-else

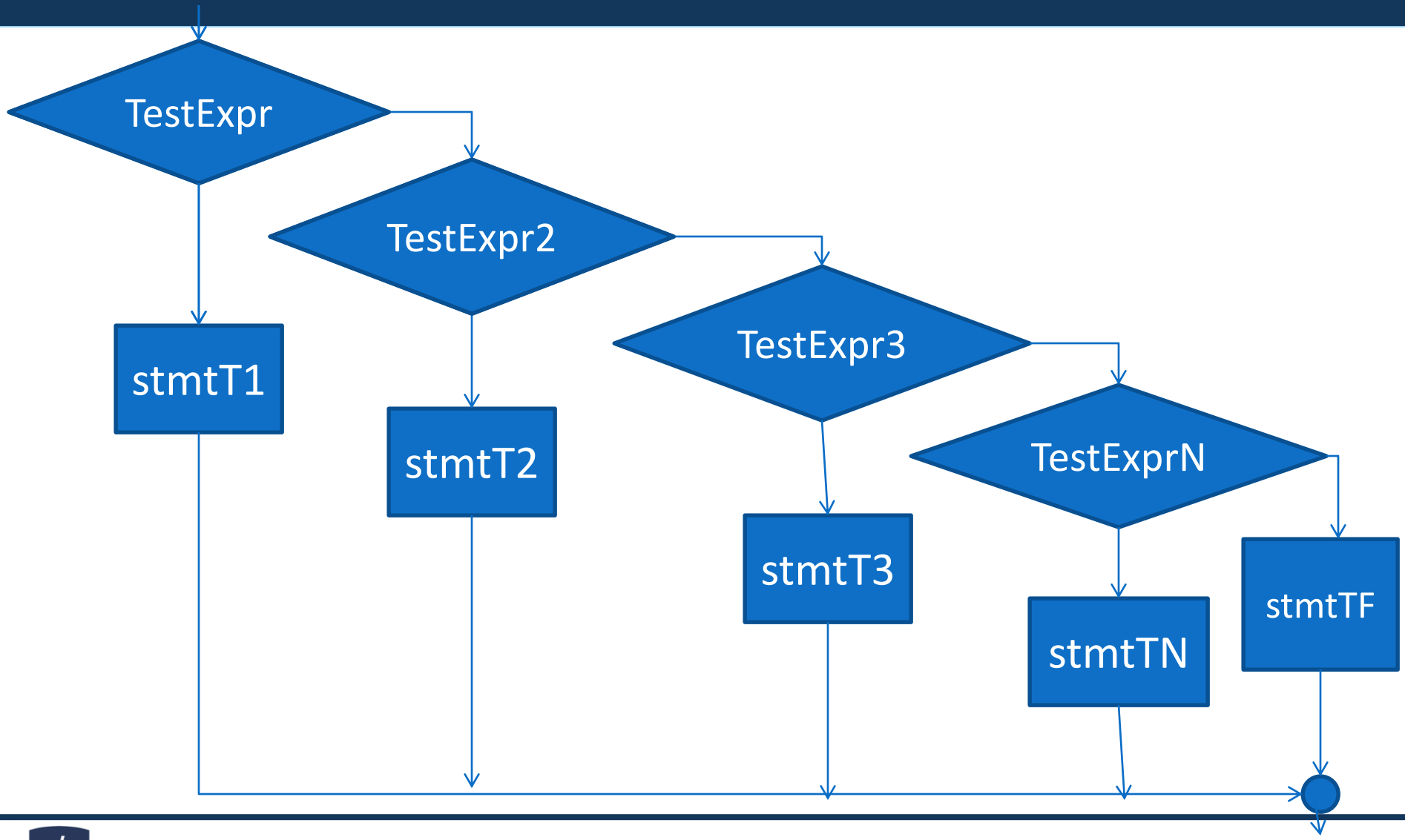
- In this nested form, `condition_1` is evaluated. If it is zero (FALSE), `statement_1` is executed and the entire nested if statement is terminated.
- If non-zero (TRUE), control goes to the second if (within the first if) and `condition_2` is evaluated.
- If it is zero (FALSE), `statement_2` is executed; if not, control goes to the third if (within the second if) and `condition_3` is evaluated.
- If it is zero (FALSE), `statement_3` is executed; if not, `statement_4` is executed. The `statement_4` (inner most) will only be executed if all the if statement are TRUE.
- Again, only one of the statements is executed other will be skipped.
- If the else is used together with if, always match an else with the nearest if before the else.
- *`statements_x`* can be a block of codes and must be put in curly braces.

SELECTION: if-else-if

- The `if-else-if` statement has the following form (3 levels example).

```
if(condition_1)
   statement_1;
else if (condition_2)
   statement_2;
else if(condition_3)
   statement_3;
else
   statement_4;
next_statement;
```

FLOWCHART OF AN IF-ELSE-IF CONSTRUCT



SELECTION: if-else-if

- `condition_1` is first evaluated. If it is non zero (TRUE), `statement_1` is executed and the whole statement terminated and the execution is continue on the `next_statement`.
- If `condition_1` is zero (FALSE), control passes to the next else-if and `condition_2` is evaluated.
- If it is non zero (TRUE), `statement_2` is executed and the whole system is terminated. If it is zero (FALSE), the next else-if is tested.
- If `condition_3` is non zero (TRUE), `statement_3` is executed; if not, `statement_4` is executed.
- Note that only one of the statements will be executed, others will be skipped.
- *`statement_x`* can be a block of statement and must be put in curly braces.

SELECTION: if-else-if-else

- If mark is less than 40 then grade 'F' will be displayed; if it is greater than or equal to 40 but less than 50, then grade 'E' is displayed.
- The test continues for grades 'D', 'C', and 'B'.
- Finally, if mark is greater than or equal to 80, then grade 'A' is displayed.

SELECTION: switch-case-break

- The most flexible selection program control.
- Enables the program to execute different statements based on an condition or expression that can have more than two values.
- Also called multiple choice statements.
- The if statement were limited to evaluating an expression that could have only two logical values: TRUE or FALSE.
- If more than two values, have to use nested if.
- The `switch` statement makes such nesting unnecessary.
- Used together with `case` and `break`.

SELECTION: switch-case-break

- The `switch` constructs has the following form:

```
switch(condition)
{
    case  template_1  : statement(s);
                break;
    case  template_2  : statement(s);
                break;
    case  template_3  : statement(s);
                break;
    …
    …
    case  template_n : statement(s);
                break;

    default : statement(s);
}
next_statement;
```

SELECTION: switch-case-break

- Evaluates the `(condition)` and compares its value with the templates following each `case` label.
- If a match is found between `(condition)` and one of the templates, execution is transferred to the `statement(s)` that follows the `case` label.
- If no match is found, execution is transferred to the `statement(s)` following the optional `default` label.
- If no match is found and there is no `default` label, execution passes to the first statement following the `switch` statement closing brace which is the `next_statement`.
- To ensure that only the statements associated with the matching template are executed, include a `break` keyword where needed, which terminates the entire `switch` statement.
- The `statement(s)` can be a block of code in curly braces.

SELECTION: switch-case-break

- The `break` statement may be omitted to allow the execution to continue to the next cases.
- The `switch-case` construct can also be nested.

SELECTION: switch-case-break

- The differences between nested if and switch:

  1. The `switch-case` permits the execution of more than one alternatives (by not placing `break`) whereas the `if` statement does not. In other words, alternatives in an `if` statement are mutually exclusive whereas they may or may not be in the case of a `switch-case`.
  2. A `switch` can only perform equality tests involving integer (or character) constants, whereas the `if` statement allows more general comparison involving other data types as well.

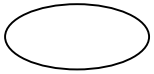
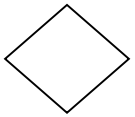
- When there are more than 3 or 4 conditions, use the `switch-case-break` statement rather than a long nested `if` statement.
- When there are multiple options to choose from.
- When test condition only use integer (or character) constants.

Flow-chart recap

A flow-chart story

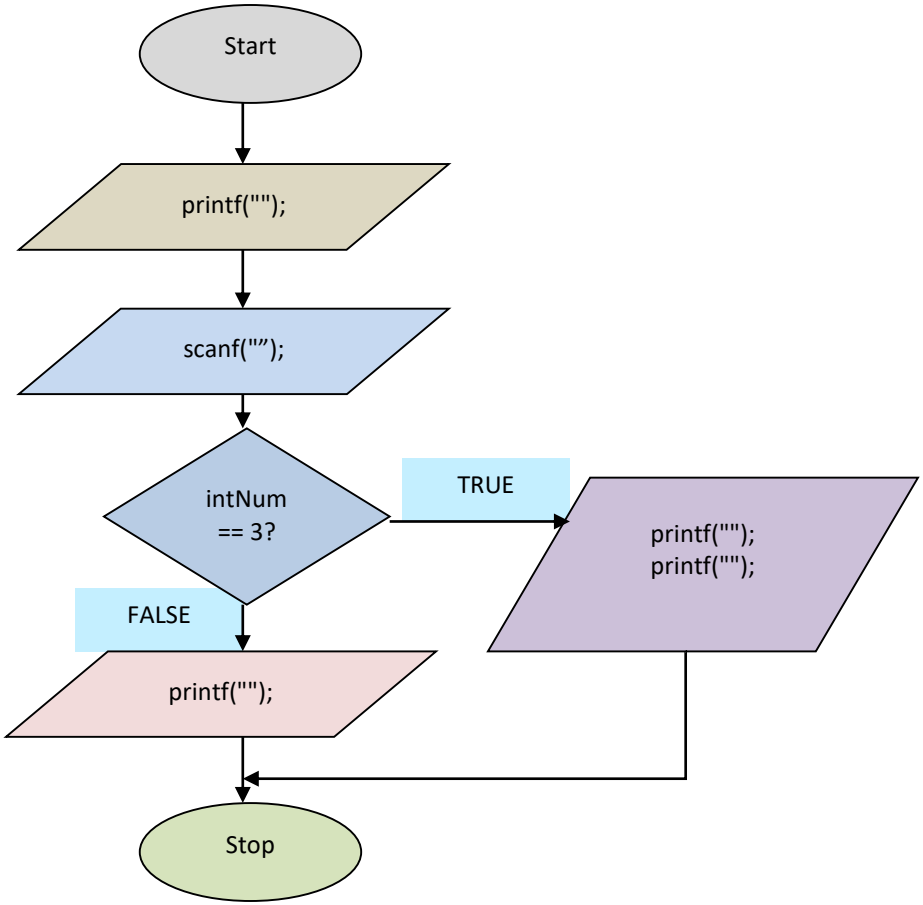
- A graphical representation of an algorithm.
- Drawn using certain symbols such as rectangles, diamonds, ovals, and small circles.
- These symbols are connected by arrows called flow lines.
- Flow-charts clearly show the program's execution order and indirectly describe how control structures operate.

Flow-chart recap

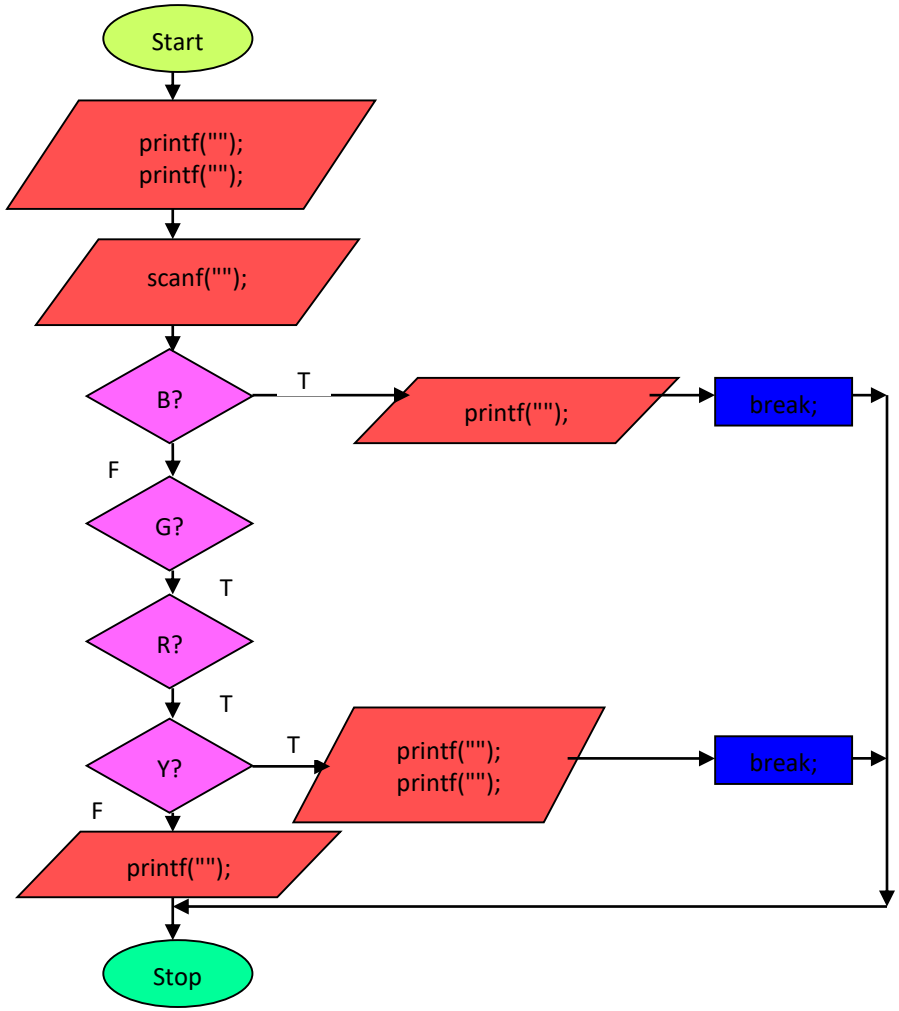
Symbol	Name	Description
	Rectangular or action	A process or an action such as calculation and assignment
	Oval	Begin/start or End/stop. Indicates a completed algorithm or program flow
	Diamond or decision	Indicates a decision to be made such as YES/NO, TRUE/FALSE, <, <= etc.
	Flow lines	Indicates the order of the actions to be executed, connecting other symbols
	Small circle or connector	Indicates a portion of a complete algorithm continued from the previous portion or to be continued to the next portion
	Input or output	The input or output such as standard input or output

Flow-chart recap

- The following flow chart examples represent C `if` selection constructs.



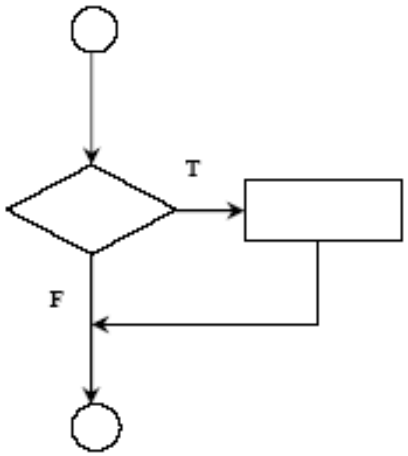
Flow-chart recap



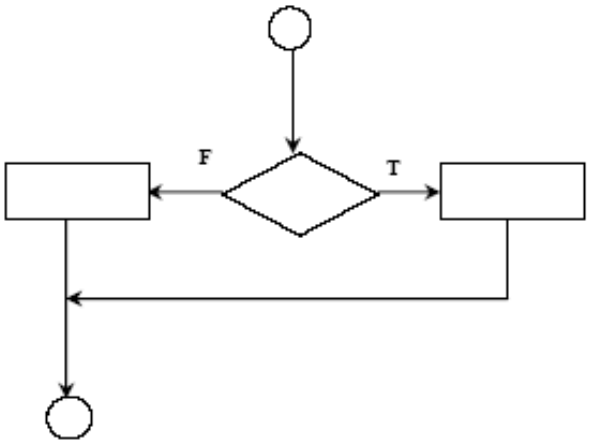
- The following flow chart examples represent C switch-case selection constructs.

Flow-chart recap

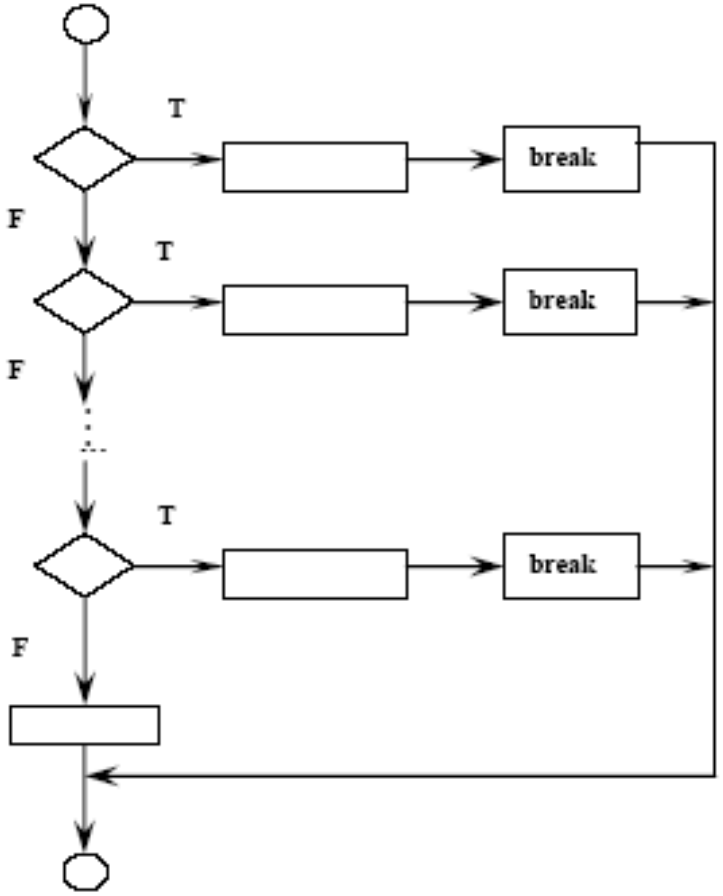
- `if`, `if-else` and `switch-case-break` flow charts



`if` structure – single selection



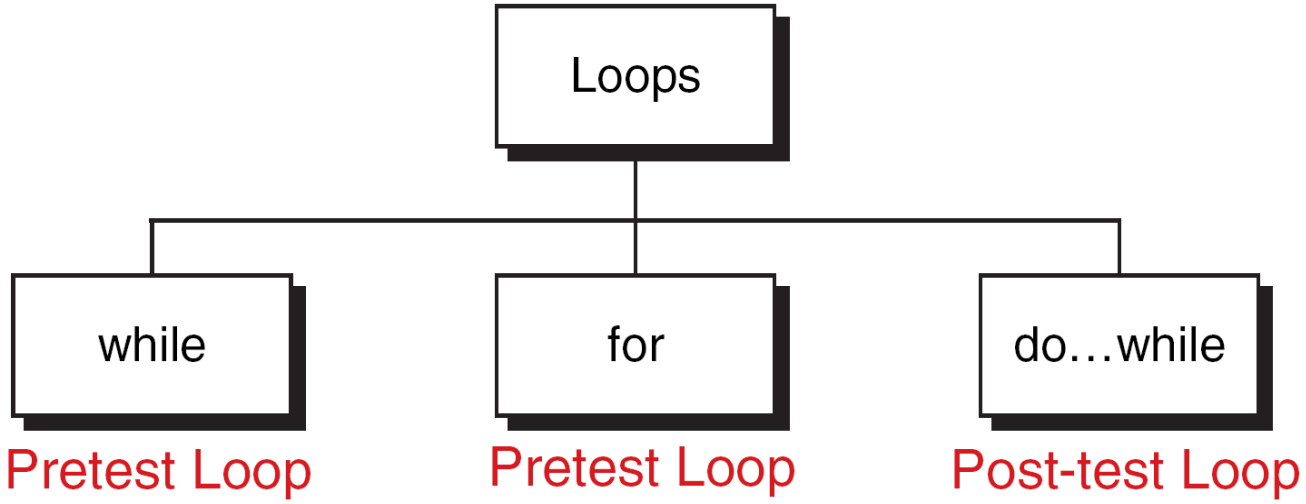
`if-else` structure – double selection



`switch` structure – multiple selections

PROGRAM CONTROL: REPETITION (LOOPS)

C has three loop statements: the **while**, the **for**, and the **do…while**. The first two are pretest loops, and the third is a post-test loop. We can use all of them for event-controlled and counter-controlled loops.



Repetition: The for loop

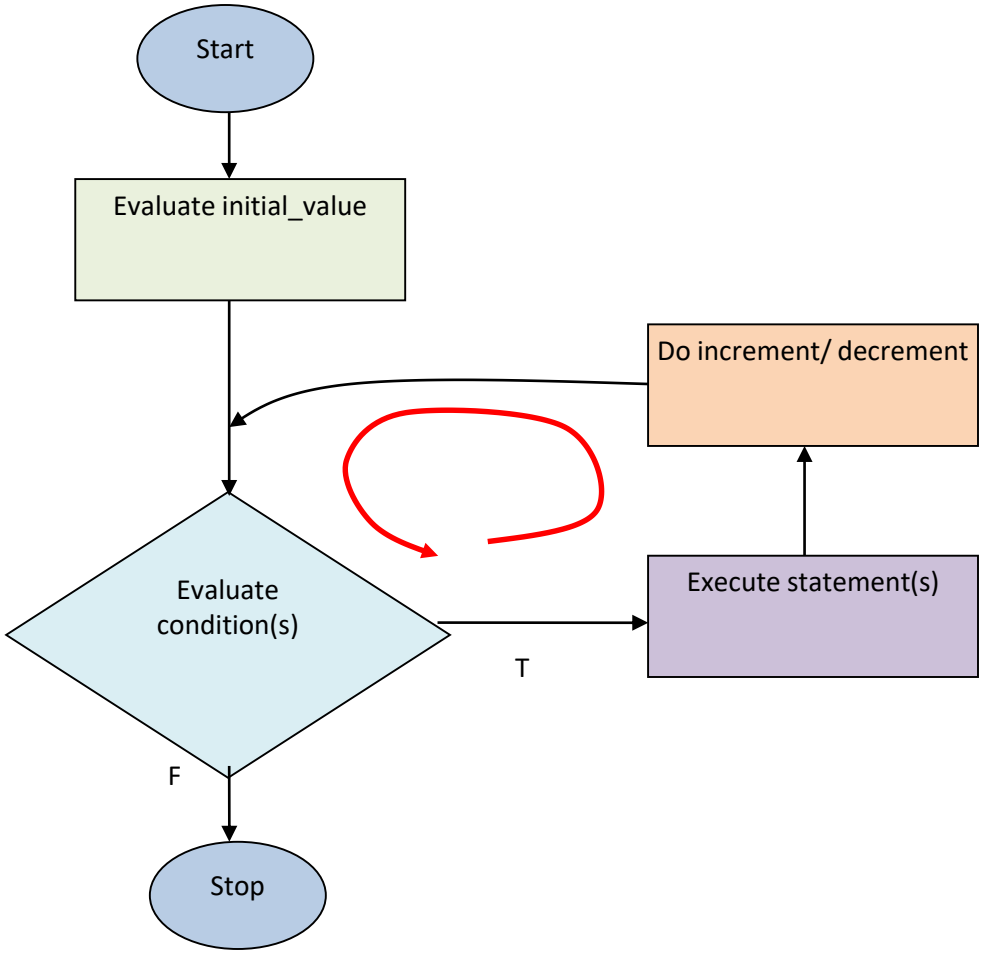
- Executes a code block for a certain number of times.
- The code block may have no statement, one statement or more.
- The `for` statement causes the `for` loop to be executed in a fixed number of times.
- The following is the `for` statement form,

```
for(initial_value;condition(s);increment/decrement)
    statement(s);
next_statement;
```

- `initial_value`, `condition(s)` and `increment/decrement` are any valid C expressions.
- The `statement(s)` may be a single or compound C statement (a block of code).
- When `for` statement is encountered during program execution, the following events occurs:
  1. The `initial_value` is evaluated e.g. `intNum = 1`.
  2. Then the `condition(s)` is evaluated, typically a relational expression.
  3. If `condition(s)` evaluates to `FALSE` (zero), the `for` statement terminates and execution passes to `next_statement`.
  4. If `condition(s)` evaluates as `TRUE` (non zero), the `statement(s)` is executed.
  5. Next, `increment/decrement` is executed, and execution returns to step no. 2 until `condition(s)` becomes `FALSE`.

Repetition: The for loop

- The `for` loop flow chart should be something like the following.



Repetition: The for loop

- A Simple `for` example, printing integer 1 to 10.

```
#include <stdio.h>
void main(void)
{
        int nCount;
        // display the numbers 1 to 10
        for(nCount = 1; nCount <= 10; nCount++){
                printf("%d", nCount);
        }
        printf("\n");
}
```

Repetition: The for loop

- A Simple `for` example, printing integer 1 to 10.

```
#include <stdio.h>
void main(void)
{
        int nCount =1;
        // display the numbers 1 to 10
        for(; nCount <= 10; nCount++){
                printf("%d\t", nCount);
        }
        printf("\n");
}
```

Repetition: The for loop

- A Simple `for` example, printing integer 1000 to 500.

```
#include <stdio.h>
void main(void)
{
        int nCount =1000;
        for(; nCount > 400; nCount-=100){
                printf("%d\t", nCount);
        }
        printf("\n");
}
```

Repetition: The for loop

- A Simple `for` example, printing integer 900 to 400.

```
#include <stdio.h>
void main(void)
{
        int nCount =1000;
        for(; nCount > 400;){
                nCount-=100;
                printf("%d\t", nCount);
        }
        printf("\n");
}
```

Repetition: The for loop

- `for` loop is a very flexible construct.
- Can use the decrementing counter instead of incrementing. For example,

```
for (nCount = 100; nCount > 0; nCount--)
```

- Can use counter other than 1, for example 3,

```
for(nCount = 0; nCount < 1000; nCount += 3)
```

- `initial_value` can be omitted if the test variable has been initialized beforehand.
- However the semicolon must still be there. For example,

```
nCount=1;
for( ; nCount < 1000; nCount ++)
```

Repetition: The for loop

- The `initial_value` can be any valid C expression, the expression is executed once when the `for` statement is first reached. For example,

```
nCount =1;
for(printf("Now sorting the array…\n"); nCount <
    100; nCount ++)
    printf("%d\n", nCount);
```

- The increment/decrement expression can be omitted as long as the counter variable is updated within the body of the `for` statement.
- The semicolon still must be included. For example,

```
for(nCount =0; nCount < 100; )
    printf("%d", nCount ++);
```

Repetition: The for loop

- The `condition(s)` expression that terminates the loop can be any valid C expression.
- As long as it evaluates as `TRUE` (non zero), the `for` statement continues to execute.
- Logical operators can be used to construct more complex `condition(s)` expressions. For example,

```
for(nCount =0; nCount < 1000 && name[nCount] != 0; nCount ++)
    printf("%d", name[nCount]);
for(nCount = 0; nCount < 1000 && list[nCount];)
    printf("%d", list[nCount ++]);
```

- Note: The `for` statement(s) and arrays are closely related, so it is difficult to define one without explaining the other (will be discussed in another Chapter).

Repetition: The for loop

- The `for` statement(s) can be followed by a null (empty) statement, so that task is done in the `for` loop itself.
- Null statement consists of a semicolon alone on a line. For example,

```
for(count = 0; count < 20000; count++)
    ;
```

- This statement provides a pause (delay) of 20,000 milliseconds.

Repetition: The for loop

- Another examples of the `for` statements,

```
nSum = 0;
for(iRow = 1; iRow <=20; iRow++){
    nSum = nSum + iRow;
}
printf("\n Sum of the first 20 natural numbers = ");
printf("%d", nSum);
```

- The above program segment will compute and display the sum of the first 20 natural numbers.
- The above example can be re-written as,

```
for(iNum = 1, nSum = 0; iNum <= 20; iNum++){
    nSum = nSum + iNum;
    }
printf("Sum of the first 20 natural numbers = %d", nSum);
```

- Take note that the initialization part has two statements separated by a comma (,).

Repetition: The for loop

- Another example,

```
for(iNum = 2, nSum=0, nSum2 = 0; iNum <= 20; iNum = iNum + 2)
{
   nSum = nSum + iNum;
   nSum2 = nSum2 + iNum * iNum;
}
 printf("Sum of the first 20 even natural numbers = %d\n", nSum);
 printf("Sum of the square for the first 20 even natural numbers =
%d", nSum2);
```

- In this example, the `for` statement is a compound or block statement.
- Note that, the initial value in the initialization part doesn't have to be zero and the increment value unnecessarily needs to be 1.

Repetition: The for loop

- We can also create an infinite or never-ending loop by omitting all the expressions or by using a non-zero constant for condition(s) as shown in the following two code snippets,

```
for( ; ; )
    printf("This is an infinite loop\n");
```

- or

```
for( ; 1 ; )
    printf("This is an infinite loop\n");
```

- In both cases, the message "`This is an infinite loop`" will be printed repeatedly, indefinitely.
- All the repetition constructs discussed so far can be nested to any degree.

Repetition: The nested for loop

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

- e.g.,

```
for (i=1;i<=100;i++){
   for(j=1;j<=50;j++){
      …
   }
}
```

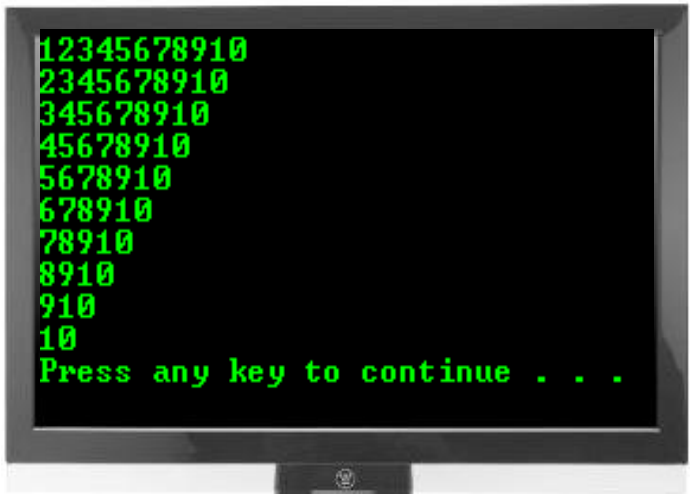
Outer loop

Inner loop

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

Repetition: The nested for loop

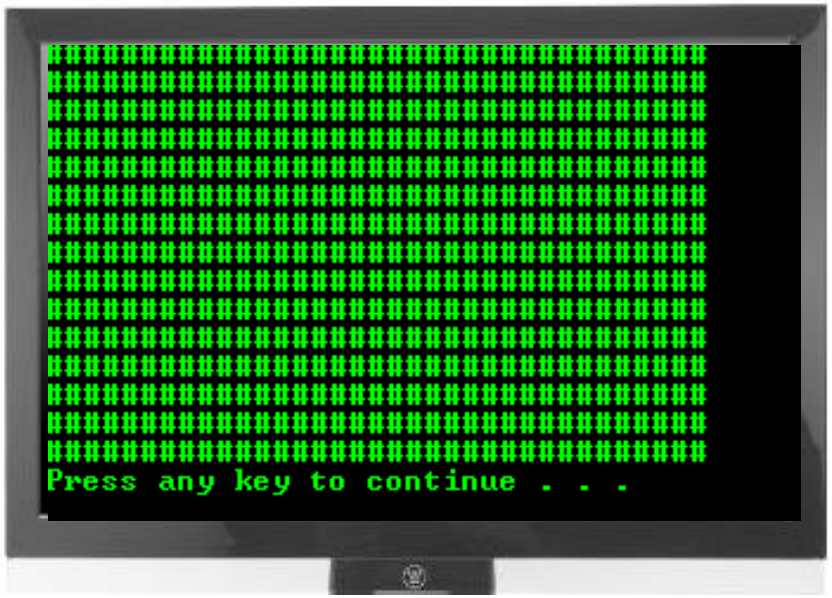
Write the program to display
the output shown on screen in right:



- The program has two `for` loops. The loop index `iRow` for the outer (first) loop runs from 1 to 10 and for each value of `iRow`, the loop index `jColumn` for the inner loop runs from `iRow + 1` to `10`.
- Note that for the last value of `iRow` (i.e. `10`), the inner loop is not executed at all because the starting value of `jColumn` is `2` and the expression `jColumn < 11` yields the value false (`jColumn = 11`).

Repetition: The nested for loop

Write the program to display the output on the screen in right:



1. In the first `for` loop, the initialization is skipped because the initial value of `row`, `10` has been initialized; this `for` loop is executed until the `row` is `1` (`row > 0`).
2. For every `row` value, the inner `for` loop will be executed until `col = 1` (`col > 0`).
3. So the external `for` loop will print the `row` and the internal `for` loop will print the `column` so we got a rectangle of `#`.

Repetition: The while loop

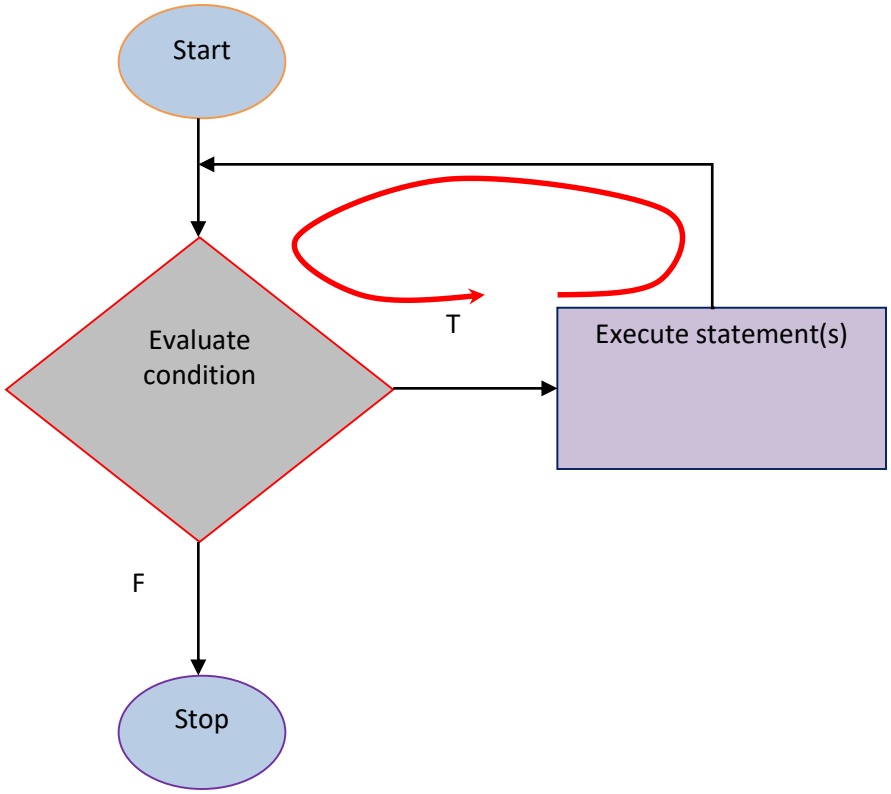
- Executes a block of statements as long as a specified condition is `TRUE`.
- The general `while` loop construct,

```
while (condition)
    statement(s);
next_statement;
```

- The `(condition)` may be any valid C expression.
- The `statement(s)` may be either a single or a compound (a block of code) C statement.
- When `while` statement encountered, the following events occur:
  1. The `(condition)` is evaluated.
  2. If `(condition)` evaluates to `FALSE` (zero), the `while` loop terminates and execution passes to the `next_statement`.
  3. If `(condition)` evaluates as `TRUE` (non zero), the C `statement(s)` is executed.
  4. Then, the execution returns to step number 1 until condition becomes `FALSE`.

Repetition: The while loop

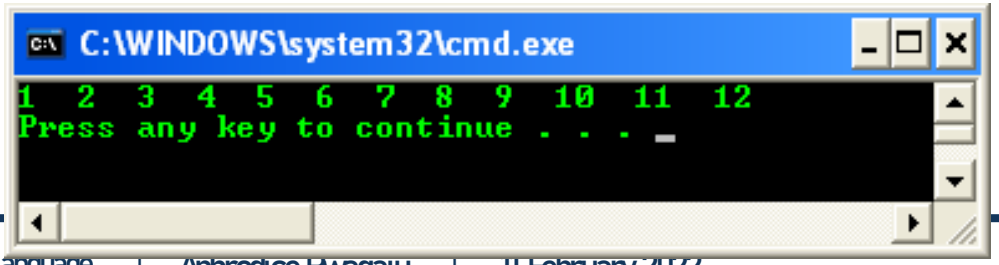
- The `while` statement flow chart is shown below.



Repetition: The while loop

- A simple example

```
// simple while loop example
#include <stdio.h>
int main(void)
{
        int  nCalculate = 1;
        // set the while condition
        while(nCalculate <= 12)
        {
                // print
                printf("%d  ", nCalculate);
                // increment by 1, repeats
                nCalculate++;
        }
            // a newline
        printf("\n");
        return 0;
}
```



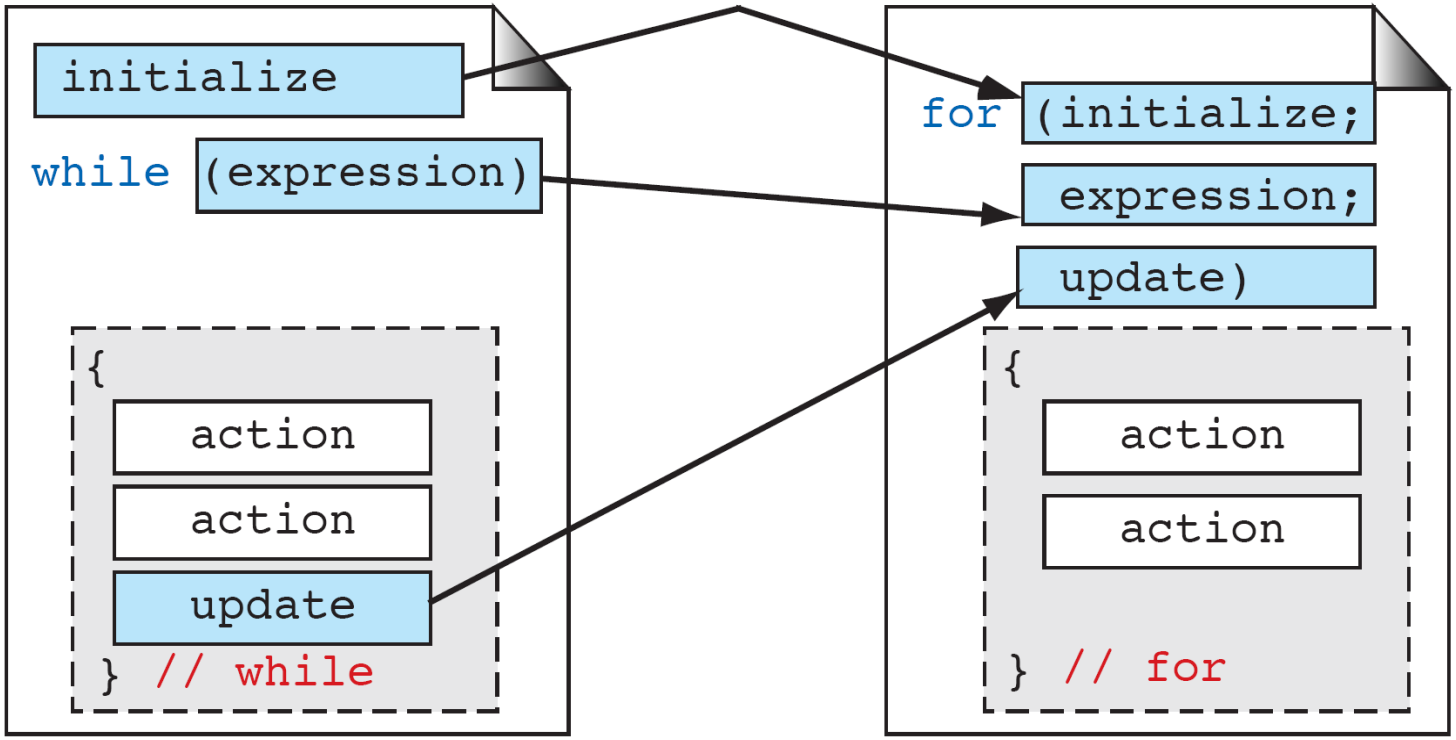
Repetition: The while loop

- The same task that can be performed using the `for` statement.
- But, `while` statement does not contain an initialization section, the program must explicitly initialize any variables beforehand.
- As conclusion, `while` statement is essentially a `for` statement without the initialization and increment components.
- The syntax comparison between `for` and `while`,

`while(condition)`	vs	`for( ; condition; )`

Repetition: The while loop

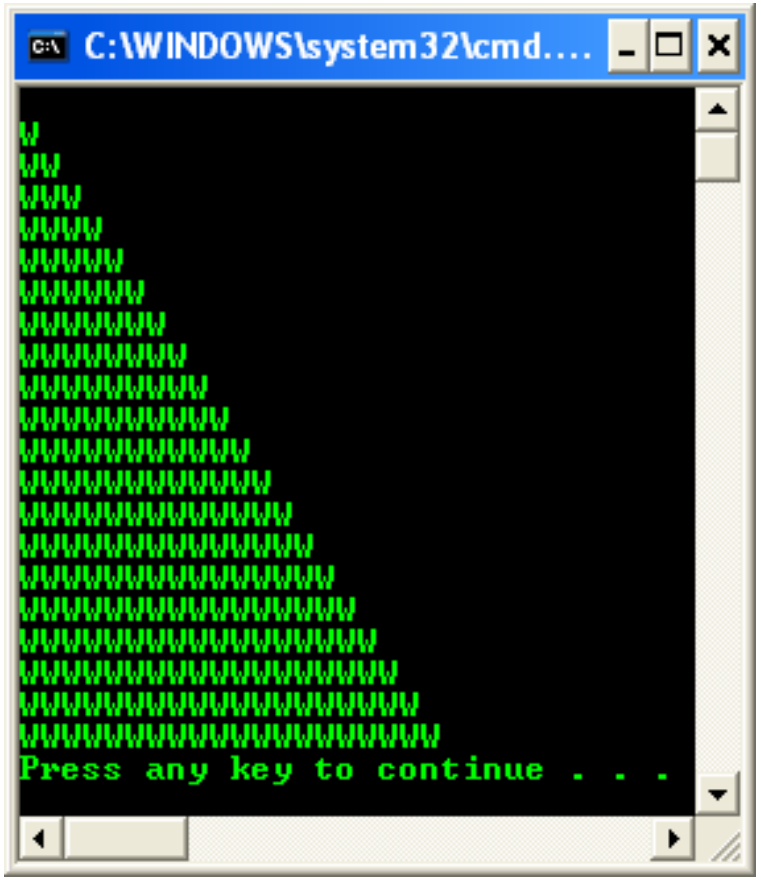
while(condition)	vs	for(; condition;)



Repetition: The while loop

- Just like for and if statements, while statements can also be nested.

Write the C program to display
The output shown on screen in right:



Repetition: The do-while loop

- Executes a block of statements as long as a specified condition is true at least once.
- Test the condition at the end of the loop rather than at the beginning, as demonstrated by the `for` and `while` loops.
- The `do-while` loop construct is,

```
do
    statement(s);
while (condition)
next_statement;
```

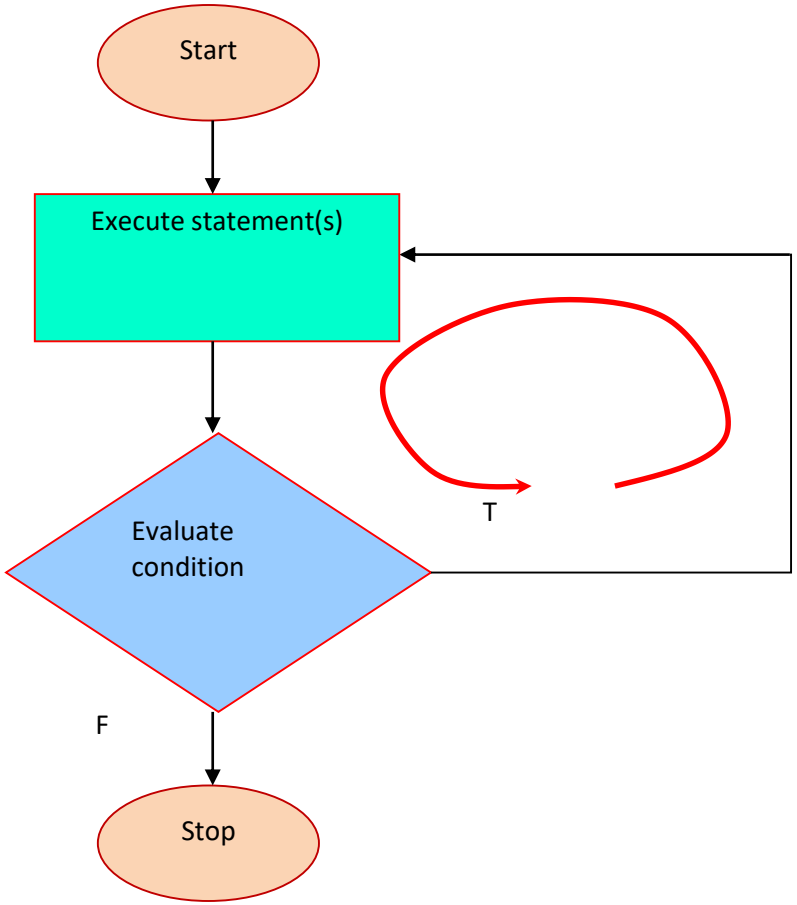
- `(condition)` can be any valid C expression.
- `statement(s)` can be either a single or compound (a block of code) C statement.
- When the program encounter the `do-while` loop, the following events occur:
  1. The `statement(s)` are executed.
  2. The `(condition)` is evaluated. If it is `TRUE`, execution returns to step number 1. If it is `FALSE`, the loop terminates and the `next_statement` is executed.
  3. This means the `statement(s)` in the `do-while` will be executed at least once.

The do-while loop example

```
#include <stdio.h>
int main()
{
   int x = 1;
   int count = 0;
   do {
         scanf("%d", &x);
         if(x >= 0) count += 1;
       } while(x >= 0);
   return 0;
}
```

Repetition: The do-while loop

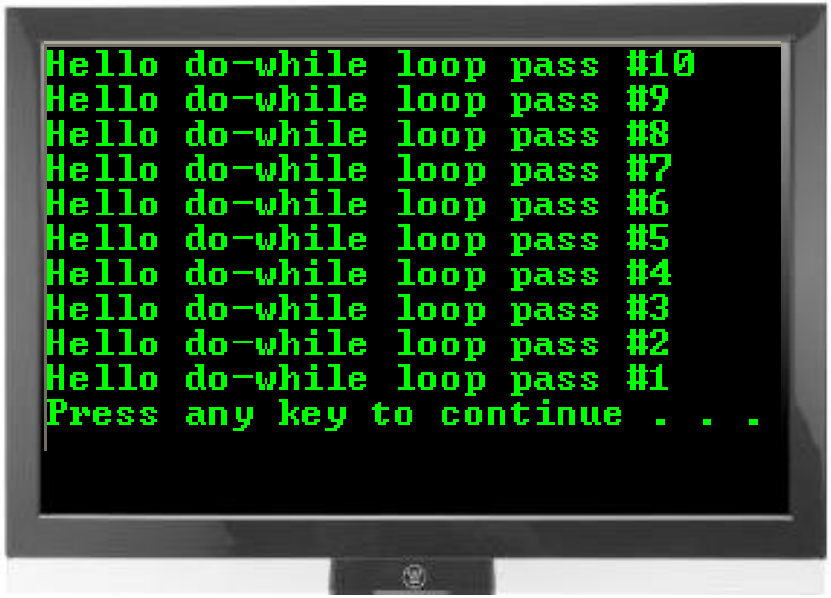
- A flow chart for the `do-while` loop



- The `statement(s)` are always executed at least once.
- `for` and `while` loops evaluate the condition at the start of the loop, so the associated statements are not executed if the condition is initially `FALSE`.

Repetition: The do-while loop

Write the program using DO WHILE to display the output shown on the screen bellow:



Comparison of Loop Choices (1/2)

Kind	When to Use	C Structure
Counting loop	We know how many loop repetitions will be needed in advance.	while, for
Sentinel-controlled loop	Input of a list of data ended by a special value	while, for
Endfile-controlled loop	Input of a list of data from a data file	while, for

Comparison of Loop Choices (2/2)

Kind	When to Use	C Structure
Input validation loop	Repeated interactive input of a value until a desired value is entered.	do-while
General conditional loop	Repeated processing of data until a desired condition is met.	while, for

SPECIAL LOOP CONTROLS: continue keyword

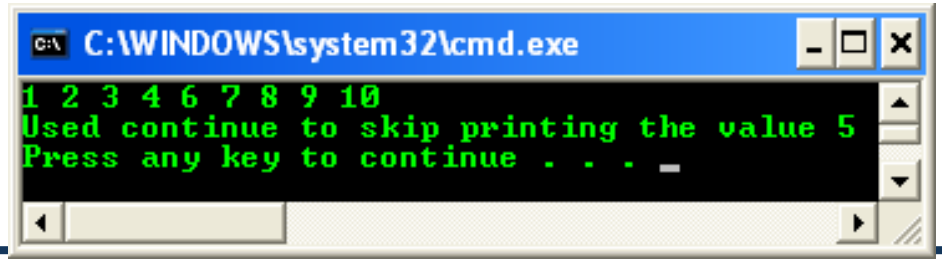
- `continue` keyword forces the next iteration to take place immediately, skipping any instructions that may follow it.
- The `continue` statement can only be used inside a loop (`for`, `do-while` and `while`) and not inside a `switch-case` selection.
- When executed, it transfers control to the condition (the expression part) in a `while` or `do-while` loop, and to the increment expression in a `for` loop.
- Unlike the `break` statement, `continue` does not force the termination of a loop, it merely transfers control to the next iteration.

continue keyword

- Consider the following **continue** keyword example

```
// using the continue in for structure
#include <stdio.h>

int main(void)
{
        int iNum;
        for(iNum = 1; iNum <= 10; iNum++)
        {
                // skip remaining code in loop only if iNum == 5
                if(iNum == 5)
                    continue;
                printf("%d ", iNum);
        }
        printf("\nUsed continue to skip printing the value 5\n");
        return 0;
}
```



continue keyword

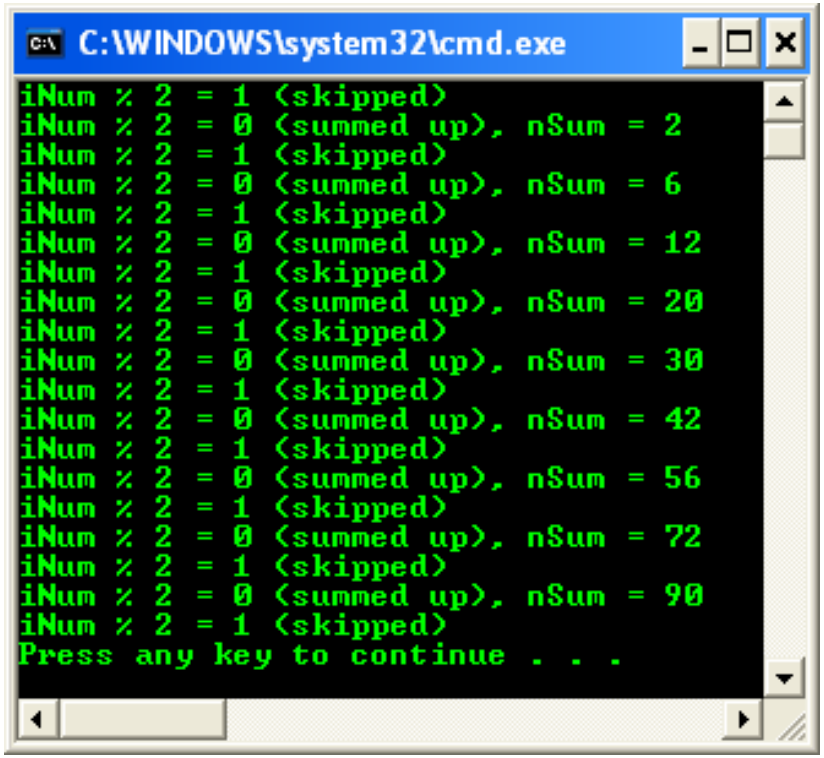
- Next consider the following **continue** keyword example

```
#include <stdio.h>

int main(void)
{
        int iNum, nSum;
        for(iNum=1, nSum=0; iNum<20; iNum++)
        {
                // test value, 0 or non-zero
                if (iNum % 2)
                {
                        printf("iNum %% 2 = %d (skipped)\n", iNum % 2);
                        // executed if the test value is non-zero
                        // and repeat the for statement
                        continue;
                }
                // executed if the test value is zero and repeat the for statement
                nSum = nSum + iNum;
                printf("iNum %% 2 = %d (summed up), nSum = %d \n", iNum % 2, nSum);
        }
        return 0;
}
```

continue keyword

- Here the loop sums up the even numbers 2, 4, 6, ... and stores the value in the `nSum` variable.
- If the expression `iNum % 2` (the remainder when `iNum` is divided by 2) yields a non-zero value (i.e., if `iNum` is odd), the `continue` statement is executed and the iteration repeated (`iNum` incremented and tested).



continue keyword

- If it yields a zero value (i.e., if `iNum` is even), the statement `nSum = nSum + iNum;` is executed and the iteration continued.
- When a `continue` statement executes, the next iteration of the enclosing loop begins.
- The enclosing loop means the statements between the `continue` statement and the end of the loop are not executed.

break keyword

- Already discussed in `switch-case` constructs.
- The `break` statement terminates the execution of the nearest enclosing loop or conditional statement in which it appears. Control passes to the statement that follows the terminated statement, if any.
- Used with the conditional `switch` statement and with the `do`, `for`, and `while` loop statements.
- In a `switch` statement, `break` causes the program to execute the next statement after the `switch`. Without a `break` statement, every statement from the matched case label to the end of the `switch`, including the `default`, is executed.
- In loops, `break` terminates execution of the nearest enclosing `do`, `for`, or `while` statement. Control passes to the statement that follows the terminated statement, if any.
- Within nested statements, the `break` statement terminates only the `do`, `for`, `switch`, or `while` statement that immediately encloses it. You can use a `return` or `goto` statement to transfer control from within more deeply nested structures.

break and continue statements

break	continue
1. It helps to make an early exit from the block where it appears.	1. It helps in avoiding the remaining statements in a current iteration of the loop and continuing with the next Iteration
2. It can be used in all control statements including switch construct.	2. It can be used only in loop constructs.

goto keyword

- The `goto` statement is one of C unconditional jump or branching.
- When program execution encounters a `goto` statement, execution immediately jumps, or branches, to the location specified by the `goto` statement.
- The statement is unconditional because execution always branches when a `goto` statement is came across, the branching does not depend on any condition.
- A `goto` statement and its target label must be located in the same function, although they can be in different blocks.
- Use `goto` to transfer execution both into and out of loop.
- However, using `goto` statement strongly not recommended.
- Always use other C branching statements.
- When program execution branches with a `goto` statement, no record is kept of where the execution is coming from.

goto keyword

The control is unconditionally transferred to the statement associated with the label specified in the goto statement. The form of a goto statement is

goto label_name;

The following program is used to find the factorial of a number.

```
#include <stdio.h>
int main()
{
  int n, c;
  long int f=1;
  printf("\n Enter the number:");
  scanf("%d",&n);
  if(n<0)
     goto end;
  for(c=1; c<=n; c++)
      f*=c;
  printf("\n FACTORIAL IS %ld", f);
  end:
   return 0;
 }
```

return keyword

- The `return` statement has a form,

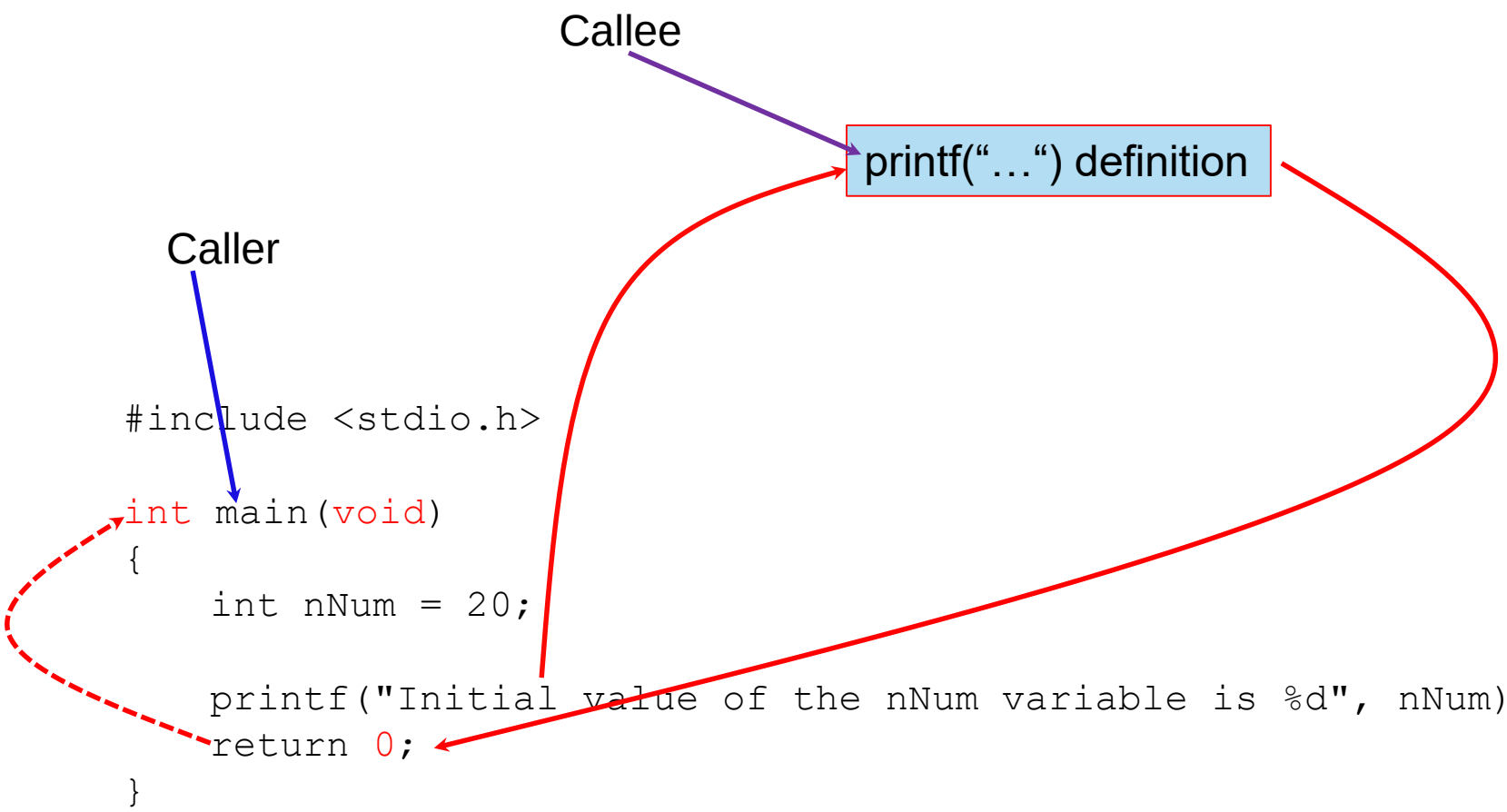
  `return expression;`

- The action is to terminate execution of the current function and pass the value contained in the expression (if any) to the function that invoked it.
- The value returned must be of the same type or convertible to the same type as the function's return type (type casting).
- More than one return statement may be placed in a function.
- The execution of the first `return` statement in the function automatically terminates the function.

return keyword

- The `main()` function has a default type `int` since it returns the value `0` (an integer) to the environment.
- A function of type `void` will not have the expression part following the keyword `return`.
- Instead, in this case, we may drop the entire `return` statement altogether.
- If a function calls another function before it is defined, then a prototype for it must be included in the calling function.
- This gives information to the compiler to look for the called function (callee).

return keyword



exit() function

- `exit()` function normally used when a program want to terminate at any time.
- The `exit()` function terminates program execution and returns control to the Operating System.
- The syntax of the `exit()` function is,

```
exit(status);
```

Status	Description
`0` (zero)	The program terminated normally.
`1` (or non-zero)	Indicates that the program terminated with some sort of error. The return value is usually ignored.

exit() function

- We must include the header file `stdlib.h`.
- This header file also defines two symbolic constants for use as arguments to the `exit()` function, such as,

```
#define  EXIT_SUCCESS  0
#define  EXIT_FAILURE  1
```

- Then we can call the function like the following,

```
exit(EXIT_SUCCESS);
```

Or

```
exit(EXIT_FAILURE);
```

atexit() function

- Used to specify, or register, one or more functions that are automatically executed when the program terminates.
- Exit-processing function that executes prior to program termination
- These functions are executed on a last-in, first-out (LIFO) basis, the last function registered is the first function executed.
- When all functions registered by `atexit()` executed, the program terminates and returns control to the OS.
- The prototype of the `atexit()` function is located in the stdlib.h and the syntax is,

```
int  atexit(void(*funct)(void));
```

- where `funct` is the function to be called.

atexit() function

- `atexit()` function takes a function pointer as its argument and functions with `atexit()` must have a return type of `void`.
- The functions passed to `atexit()` cannot take parameters.
- `atexit()` uses the heap (instead of stack) to hold the registered functions.
- The following program pushes three functions onto the stack of functions to be executed when `atexit()` is called.
- When the program exits, these programs are executed on a last in, first out basis.

system() function

- The `system()` function, enables the execution of OS command from the C running program.
- Can be quite useful, for example, enabling the program to do a directory listing or formatting a disk without exiting the program.
- Must include the header file stdlib.h. The syntax is,

```
system("command");
```

- The command can be either a string constant or a pointer to a string.

system() function

- For example, using an argument with the `system()` function,

```
char *command = "dir";
system(command);
```

- After the OS command is executed, the program continues at the location immediately following the `system()` call.
- If the command passed to the `system()` function is not a valid OS command, a bad command or file name error message is displayed before returning to the program.
- The command can also be any executable or batch file to be run.

abort() Function

Function	Description
`abort()`	Abort current process and returns error code defined in `stdlib.h`

1. The syntax is,

```
void abort( void );
```

1. `abort()` does not return control to the calling process. By default, it terminates the current process and returns an exit code of 3.
2. By default, the abort routine prints the message:

```
"This application has requested the Runtime to terminate it in an unusual way. Please contact the application's support team for more information."
```

End Of File (EOF)

- We use `EOF` (acronym, stands for End Of File), normally has the value `-1`, as the sentinel value.
- The user types a system-dependent keystroke combination to mean end of file that means 'I have no more data to enter'.
- `EOF` is a symbolic integer constant defined in the `<stdio.h>` header file.
- The keystroke combinations for entering `EOF` are system dependent.
- On UNIX systems and many others, the `EOF` is <Return key> or ctrl-z or ctrl-d.
- On other system such as old DEC VAX VMS or Microsoft Corp MS-DOS, the EOF is ctrl-z.

Homework (1/5)

- Write a program that prompts the user to input an integer ***n***.
- Draw a triangle with ***n*** levels by star symbols. For example,

n = 4,

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

- After drawing the triangle, repeat the above process until the user input a negative integer.

Homework (2/5)

- An usage scenario:

```
Please input a number: 2
*
* *
Please input a number: 3
*
* *
* * *
Please input a number : 4
*
* *
* * *
* * * *
Please input: -9
Thank you for using this program.
```

Homework (3/5)

Write a program draw the following shapes using star symbols:

a)

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

b)

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

c)

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

d)

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

Homework (4/5)

e)

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

f)

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

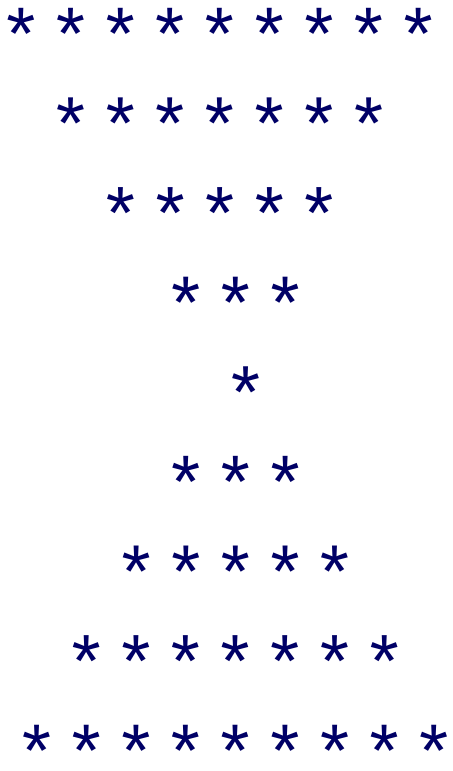
g)

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

Homework (5/5)

h)

g)



EOF