10 Server Side Scripting Using PHP

After the completion of this chapter, the learner

- lists the benefits of using PHP.
- explains the syntax of PHP code.
- describes the client server environment.
- illustrates various data types and operators used in PHP.
- constructs code from algorithm using control and looping structures in PHP.
- designs PHP functions for common tasks.
- identifies date, time and string functions.
- differentiates between static and dynamic web page.
- selects the appropriate data submitting methods for different scenarios.
- identifies the role of database connectivity in the creation of dynamic web pages.

In the previous chapters we learned about HTML and client-side scripting using JavaScript and now we know how to embed a Java script in HTML. In this chapter we will learn server side scripting using PHP and see how we can embed a PHP code into HTML along with JavaScript. The basic syntax of PHP is similar to that of C++ and Java script, and embedding the PHP code in HTML is similar to Java script. So learning PHP will be easy and interesting.

10.1 Overview of PHP

PHP is one of the most popular server side scripting languages available. It is used for creating dynamic web pages. PHP stands for PHP Hypertext Preprocessor. Usually, PHP runs on a web server and is available on different operating systems and platforms. Furthermore, PHP is an interpreted language and a PHP script is processed by the PHP engine each time it runs. PHP is an HTML embedded language which means that we can write PHP statements within an HTML code. When a PHP script is run it processes the information and produce hypertext (HTML) as a result.

Rasmus Lerdorf (born on 22 November 1968) is a Greenlandic programmer with Canadian citizenship. He created the PHP scripting language. It was first created by him in 1995, and its first official release was in 1997. He is known as the Father of PHP. He authored the first two versions of the language and participated in the development of later versions. He continues to contribute to the project. The official website of PHP is www.php.net

Rasmus Lerdorf

PHP is an open-source project and is completely free, and is supported by a worldwide community of volunteers. It is more robust and error-free than many other server side scripting languages and can access more than 20 different databases including MySQL. **PHP** can also be used to output images, PDF files and Flash movies. As **PHP** is free, it helps organisations in reducing the overall development cost by allowing them to save on licensing fees and expensive server hardware. At the same time **PHP** also helps to produce higher quality products within a short span of time. As a result of this, today, many large-scale websites are developed in **PHP.**

As per recent statistical data, PHP is installed on more than 20 million websites and around 1 million web servers around the world.

10.1.1 Benefits of using PHP

We know that client-side scripts are executed faster since they are run at the client. Even though it is fast it has certain limitations. A client-side scripting language is usually dependent on the browser in which it is run. More over the JavaScript code is visible to the user through the "view source" option of the browser. This makes it less secure.

On the other hand, in the case of PHP, code is executed on the server, and not on the client browser. This allows us to write a program code that is completely independent of browsers. Further, because the code is executed on the server and only the output is sent to the client, it is impossible for users to see the source code of a PHP program.

Benefits of PHP can be consolidated as follows:

- As PHP can be easily embedded into HTML, it is easy to convert an already existing static website into a dynamic one.

- It is compatible with a wide variety of databases.
- It is an independent platform and can run across Windows, Linux or Mac servers.
- It supports most current web servers and interfaces very easily with Apache/ MySQL.
- It is simple and easy to learn.
- It operates much faster than other scripting languages, since PHP does not use a lot of system's resources in order to run.
- PHP offers many levels of security to prevent malicious attacks.
- It has a huge support from open source community.
- PHP is completely free and is an open source software product and can legally be used for personal and commercial web site development.

www.hscap.kerala.gov.in, the Kerala State Higher Secondary single window

10.1.2 Basics of PHP

A. Setting up the development environment

We need to set up a web development environment in our computer for a PHP program to run successfully. For this we need to install a PHP compatible web server and PHP interpreter on our machine. They can be installed separately or from a set of free open source software package like WAMP, LAMP or XAMPP, which includes Apache web server, MySQL and PHP. WAMP is for windows, LAMP stack for Linux and XAMPP will work on both Windows and Linux.

After installing a web server, start the web server from the menu. Open the web browser and type "http://localhost" or "http://127.0.0.1" in the address bar. If we see an administration screen corresponding to the installed web server in the web browser, we can confirm that the web server installation is working properly.

B. Writing and running the script

PHP scripts are merely plain text containing PHP instructions. Apart from a simple text editor, no other additional software is required to create PHP code. Within the text document, PHP scripting should begin with "< ?php" and end with "?>". When the web server sees this tag, it understands that it is a PHP code that is in between the tags and that it executes the code. The PHP code containing text documents are to be saved with" **.php"** extension in the **root directory** of the web server.

WAMP, XAMPP and LAMP

WAMP, LAMP and XAMPP are used for serving PHP websites and acts as the local server, so that we can see our working website on our computer. All these software help us in reducing the complexity of deployment and handling of services like database handling, code manipulation etc.

WAMP stands for Windows, Apache, MySQL, PHP. WAMPs are packages of independently-created programs installed on computers that use a Windows operating system. The advantage of using WAMP is that it is easy to setup. WAMP is available at www.wampserver.com/en/.

XAMPP stands for X-OS, Apache, MySQL, PHP, PERL. X-OS means it can be used for any operating system. XAMPP is easier to use for a beginner. XAMPP is available at http://www.apachefriends.org/en/xampp-windows.html

LAMP stands for Linux, Apache, MySQL, PHP. LAMP is an open source Web development platform that uses Linux as the operating system. Because the platform has four layers, LAMP is sometimes referred a LAMP stack.

Let us try out an example step by step.

Step 1: Open a new document in a text editor (e.g.: Notepad, Gedit) and type in the following code.

```
<?php
    // this line of code displays a message
    echo 'My First PHP Program';
?>
```

Step 2: Save the file in the web server's document root directory (like "C:\wamp\www"in the case of WAMP server or \var\www in LAMP), under a suitable name with a .PHP extension (e.g.: example.php).

Fig. 10.1: Output of the program First.php

Step 3: Start the web server if it is not **ON**.

Step 4: Then, open the web browser, and type the URL corresponding to the file location (e.g: http://localhost/example.php) in the address bar to get the output as in Figure 10.1.

In PHP, each line of code is to be terminated with a semi colon (;). For the last statement of PHP code semi colon is not compulsory.

The default root directory for WAMP is "C:\wamp\www", for XAMPP "C:\xampp\htdocs" and for LAMP in Ubuntu is "/var/www".

The process of running a PHP script on the web server may be consolidated as follows:

1. We request a web page by typing the page's URL (e.g.: http://localhost/first.php) in the browser's address bar.
2. The web server recognises that the requested URL is a PHP script, and instructs the PHP engine to process and run the script.
3. The script runs, and when it is finished, it sends an HTML page containing the result back to our web browser.

Let us do

Create a folder named "letusdo" in your web servers root directory and copy few files (any files) into it, do the following and observe the output.

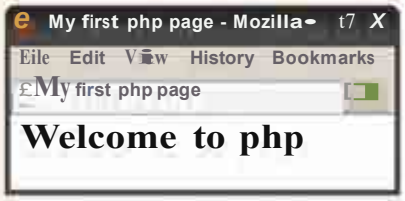
a. Try the URL http://localhost/letusdo in browser's address bar.
b. Create an HTML file with name "index.html" in "letusdo" folder and try the previous URL.
c. Create a PHP file with name "letusdo.php" in "letusdo" folder and try the URL http://localhost/letusdo/letusdo.php.

C. Combining HTML and PHP

PHP and HTML are closely related to each other and often function together. PHP generates HTML and HTML passes information to PHP. We embed the PHP code into standard HTML documents using the special tags "<?php" and "?>". PHP source code is flexible and can be placed anywhere in a document. Anything outside of PHP tags is read as HTML.

Program 10.1: PHP script in HTML document

```
<HTML>
<HEAD>
<TITLE> My first php page</TITLE>
</HEAD>
<BODY>
<?php
 echo "<H2> Welcome to php </H2>";
?>
</BODY>
</HTML>
```



When this HTML document is requested by a user, the web server recognises and executes the PHP code blocks and embeds the resulting output into the HTML document before returning it to the requesting user.

D. Comments in PHP

In PHP code, a comment is a line that is not read/executed as part of the program. There are two types of comments in PHP, single line comment (//) and multiline comment (/ /).

Program 10.2: PHP script in HTML document

```
<?php
   /* Program to display the message
   Welcome to php */
   echo "Welcome to php"; //Shows a message
2>
```

E. Output statements in PHP

PHP provides various constructs and functions for getting output. They can be used to output various data types like integer, float, string, arrays, objects etc.

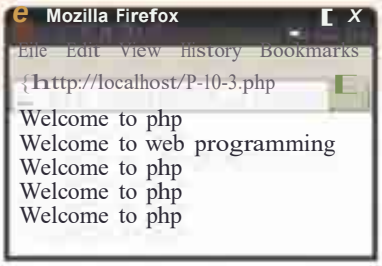
(i) echo and print

In PHP, the two basic constructs 'echo' and 'print' are used to display output on a web page. Both constructs can output all types of data, but multiple outputs can be made only with echo command.

The echo and print statement can be used with or without parentheses.

Program 10.3: PHP script in HTML document

```
<?php
   echo "Welcome to php<BR>", "Welcome to web programming<BR>";
   echo ("Welcome to php<BR>");
   print "Welcome to php<BR>";
   print ("Welcome to php<BR>");
?>
```



The following table illustrates the difference between `echo` and `print` statements.

echo	print
Can take more than one parameter when used without parenthesis.	Takes only one parameter
Does not return any value.	Returns TRUE or 1 on successful output and FALSE if it was unable to print out the string.
Little faster than print.	Little bit slower than echo

Table 4.1: Comparison between `echo` *and* `print`

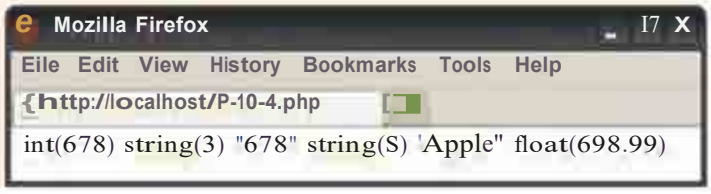
(ii) Var_dump ()

The `var_dump ()` function is used to display both data type and value of variables. It can be used to display integer, float, string, arrays, objects etc. Its syntax is as follows.

```
var_dump(variable1, variable 2, ....variable n)
```

Program 10.4 Program to demonstrate var_dump()

```
<?php
    $a1=678;
    $a2="678";
    $a3="Apple";
    $a4=698.99;
    var_dump($a1);
    var_dump($a2);
    var_dump($a3);
    var_dump($a4);
?>
```



10.2 Fundamentals of PHP

In this section we will discuss variables, data types and operators in PHP.

10.2.1 Variables

In PHP, a variable name starts with the $ sign, followed by the name of the variable. Unlike other programmin g languages, in **PHP** a variable does not need to be declared before using it. It is created when we first assign a value to it. PHP automatically determines the data type of the variable, depending on the type of value assigned to it.

```
$Var_name= value;
```

```
<?php
   $txt = "Hello world";
   $x = 25;
   $y = 23.5;
?>
```

After the execution of the statements above, the variable $txt will hold the value Hello world, the variable $x will hold the value 25, and the variable $y will hold the value 23.5. Put quotes around the value while assigning a text value to a variable.

Variable naming conventions in PHP

A variable can have a short name (like m and n) or a more descriptive name (like Age, Reg_No, Amount).

Rules for forming PHP variable names:

- A variable name must start with the$ sign, followed by the name of the variable.
- The name of the variable must start with a letter or the underscore character.
- The name of the variable can only contain alpha-numeric characters and underscores (a-z,A-Z, 0-9, and_)
- Variable names are case-sensitive ($name and $NAME are two different variables)
- Punctuation characters such as commas, quotation marks, periods or spaces are not allowed in variable names.

10.2.2 Data types

We know that variables can store data of different types, and different data types are used differently. The data types in PHP can be divided and grouped as in Figure 10.2.

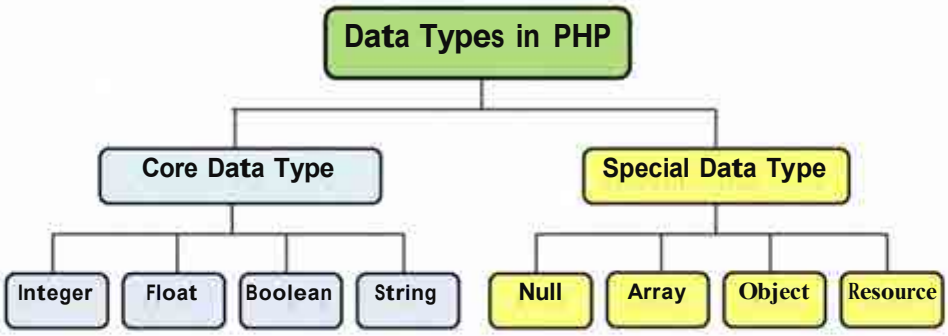


Fig. 10.2: Data types in PHP

A. Core Data Types

The core data types integer, float/double and string data types are almost similar to what we have learned in C++. The size of an integer or float is platform-dependent

Integer

Integers are whole numbers. It does not include precision. Negative values are also considered as integers. PHP does not support unsigned integer data type.

Example: -32, 32, 986 etc.

Float/Double

Fractional numbers are grouped as floating point numbers or double data type.

Example: 123.56, 5.6, 1.2e3, 7E-10 etc.

String

Strings hold both words and sentences. These are always inserted within quotation marks. Both single and double quotes can be used to represent strings. But while using quotes, the quotes used at the beginning and end of the string should be of the same type. That is, if a string representation started with a single quote then it should also end with a single quote.

Example: "Apple", 'PHP' etc.

Boolean

A Boolean data type can represent two possible states: TRUE or FALSE. Booleans are often used in conditional testing. As discussed earlier, PHP is a case sensitive programming language. So we can use only the defined set of Boolean values like, `yes/no`, `on/off`, `1/0`, `true/false` etc.

```
<?php
   $a=true;     // assign the value TRUE to $a
   $b=0;        // assign the value FALSE to $b
?>
```

B. Special data types

Null

Null is a special data type which can have only one value: NULL. PHP will consider a variable as NULL, if we do not set it. NULL data type can also be used for emptying variables.

```
$x = null;  //$x is assigned a null value
```

Array

Arrays are variables that hold multiple values. In PHP each array element holds a key and a value. We have three types of array: indexed array, associative array and multidimensional array. Arrays are discussed in detail in Section 10.4.

Object

Object data type in PHP is similar to an object in C++. An object can contain variables and functions that process the variables. In PHP, an object must be explicitly declared. At first a class is declared and then instances which are objects of the class are created using the command 'new'.

Resources

The resource type is not an actual data type. Resources are special variables that hold references to other external resources like file handler, database object etc. Resources are created and used by special functions.

10.2.3 Operators in PHP

Operators used in PHP are grouped and named categorically as:

a. Assignment operators
b. Arithmetic operators
c. Relational operators
d. Logical operators
e. String operators
f. Combined operators

a. Assignment operators

Assignment operators are used to assign a value to a variable directly or from another variable. The equal character(=) is used as assignment operator.

```
$my_var = 4; //$my_var is assigned a value 4
$new_var = $my_var; //$new_var is assigned the value of $my_var
```

b. Arithmetic operators

Operator	Meaning	Example	Result
+	Addition	3 + 2	5
-	Subtraction	5 - 3	2
*	Multiplication	6 * 5	30
/	Division	9 / 3	3
%	Modulus	10 % 3	1

c. Relational operators

Operator	Meaning	Example (x = 3, y = 5)	Result
==	Equal to	$x == $y	False
!=	Not equal to	$x != $y	True
<	Less than	$x < $y	True
>	Greater than	$x > $y	False
<=	Less than or equal to	$x <= $y	True
>=	Greater than or equal to	$x >= $y	False

d. Logical Operators

Operator	Meaning	Example (a= 7, b =2, c = 9)	Result
and	Returns True if two or more relational expressions are true	(a>b) and (a>c)	False
&&	Returns True if two or more relational expressions are true	(a>b) && (a>c)	False
or	Returns True if at least one of the given relational expressions is true	(a>b) or (a>c)	True
||	Returns True if at least one of the given relational expressions is true	(a>b) || (a>c)	True
xor	Returns True if only one of two expressions is true	(a>b) xor (a>c)	True
!	Returns True if an expression is not true	! (a>b)	False

e. String operators

There are two types of string operators, the **concatenating operator('.')** and the **concatenating assignment operator('.=')**. The concatenating operator joins the right and the left string into a single string. The concatenating assignment operator adds the argument that is placed on the right side of the equal operator with the argument placed on the left side of the 'equal' operator.

Program 10.5 Program to illustrate the concatenation operation

```
<HTML>
<BODY>
  <?php
    $string1= 'Good';
    $string2= ' Morning';
    $newstring = $string1. $string2;  //concatenation
    $string1 .= $string2;  //concatenation assignment
    echo $newstring. "<BR>";
    echo $string1;
  ?>
</BODY>
</HTML>
```

f. Combined operators

Combined operators are the combination of different types of operators, just like inC++.

Operator	Meaning	Example	Equivalent Operation
+=	Plus Equals	$x += 2;	$x = $x + 2;
-=	Minus Equals	$x -= 4;	$x = $x - 4;
*=	Multiply Equals	$x *= 3;	$x = $x * 3;
/=	Divide Equals	$x /= 2;	$x = $x / 2;
%=	Modulo Equals	$x %= 5;	$x = $x % 5;
.=	Concatenate Equals	$string1 .="hello";	$string1= $string1. "hello";

g. Increment and decrement operators

Operator	Meaning	Example (if x = 2)	Output
++value	Pre increment	echo ++$x;	3
--value	Pre decrement	echo --$x;	1
value++	Post increment	echo $x++;	2
value--	Post decrement	echo $x--;	2

h. Escape sequences

In PHP, a single character, headed by a back slash(\), is an escape character. The HTML <PRE> tag is used to display escape sequences in the user's browser.

Operator	Meaning	Statement	Output
\"	Print double quote	echo "\"Hello\"";	"Hello"
\'	Print single quote	echo "Raju\' s";	Raju's
\n	Print new line char	echo "Raju\nHari";	Raju Hari
\t	Print tab	echo "Raju\tHari";	Raju Hari
\r	Print carriage return		
\$	Print$	echo "50\$";	50$
\\	Print backslash	echo "C:\\Windows";	C:\Windows;

Know your progress

1. PHP stands for _____.
2. PHP files have a default file extension of _ _ _ _.
3. Who is known as the Father of PHP?
4. In PHP _ is used for a single line comment.
5. WAMP stands for _ _ _ _.
6. LAMP stands for _____.
7. A PHP script should start with _____ and end with _____.
8. Variables always start with a _____ In PHP
9. The PHP syntax is similar to that of _____ language.
10. What is the use of var_dump O?
11. The dot (.) operator is used for _____.

10.3 Control structures in PHP

The 'Control Structure' controls the program flow of PHP Conditional statements, such as if/else and switch, allow a program to execute different pieces of code, or none at all, depending on some condition. Loops, such as while, do - while and for, support the repeated execution of particular code.

10.3.1 Conditional statements in PHP

a. if statement

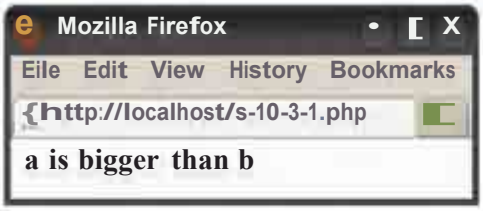
The `if` statement checks the truthfulness of an expression and, if the expression is `true`, evaluates a statement.

Syntax

```
if (expression)
{
  //code to execute if the
  //expression evaluates to true
}
```

Example (Check whether a is big)

```
<?php
 $a= 10;
 $b = 5;
 if ($a > $b)
  echo "a is bigger than b";
?>
```



b. else statement

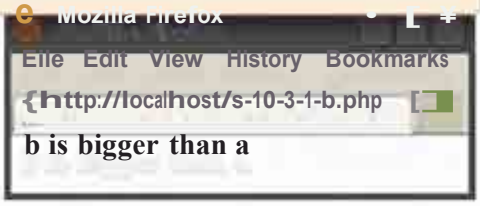
The `else` statement defines an alternative block of code that should be executed if the expression we are testing evaluates to `false`.

Syntax

```
if (expression)
{
//code to execute if the
//expression evaluates to true
}
else
{
//code to execute if the
//expression evaluates to false
}
```

Example (Find the biggest of two numbers)

```
<?php
$a= 10;
$b = 65;
if ($a > $b)
    echo "a is bigger than b";
else
    echo "bis bigger than a";
?>
```



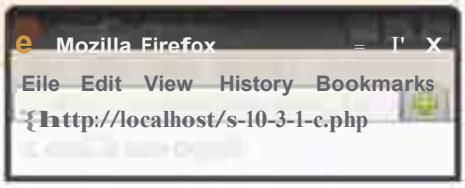
c. elseif statement

Syntax

```
if (expression)
{
}
elseif (expression)
{
}
elseif (expression)
{
}
else
{
//code to execute in all other cases.
}
```

Example
(Find the biggest of two numbers)

```
<?php
$a = 55;
$b = 55;
if ($a> $b)
  echo "a is bigger than b";
elseif ($b > $a)
  echo "bis bigger than a";
else
  echo "a and bare equal";
2>
```



a and b are equal

d. switch statement

The switch statement is similar to a series of if statements on the same expression. Its syntax and working is exactly similar to that of switch statement in C++. One notable difference is that switch in PHP can accept strings as case identifiers.

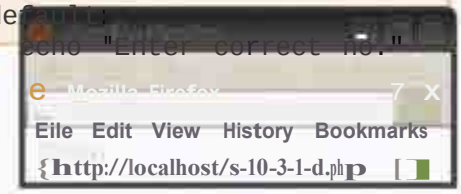
Syntax

```
switch (expression)

 case resultl:
   //execute this if result of
   //expression is resultl
   break;
 case result2:
   //execute this if result of
   //expression is result2
   break;
 default:
   //execute this if result of
   //expression does not match
   //any case results
```

Example
(Print a no. from 1 to 3 in words)

```
<?php
$n = 3;
switch ($n)
    case 1:
       echo "One";
       break;
    case 2:
       echo "Two";
       break;
    case 3:
       echo "Three";
       break;
    default:
       echo "Enter correct no.";
}?>
```



Three

10.3.2 Loops in PHP

a.while loop

The 'while' control structure executes the nested statements repetitively **until** the expression returns a **false** value.

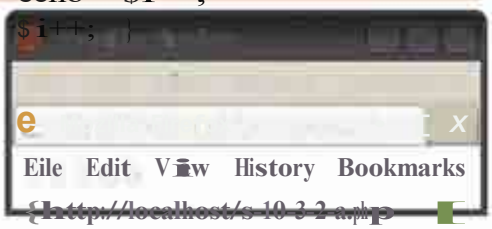
Syntax

```
while (expression)
{
 //code to execute if the
 //expression evaluates to true
}
```

Example
(Prints natural numbers from 1 to 5)

```
<?php
$i = 1;

while ($i <= 5)
{ echo "$i ";
$i++; }
?>
```



12345

b.do-whileloop

The do ... while statement will execute a block of code at least once -it then will repeat the loop as long as the condition is **true**.

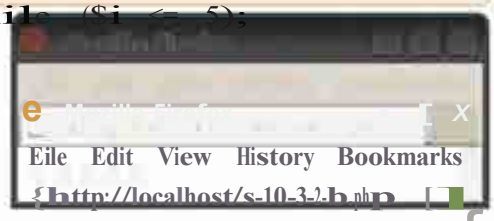
Syntax

```
do
{
 //code to execute if the
 //expression evaluates to true
} while (expression);
```

Example
(Prints natural numbers from 1 to 5)

```
<?php
$i = 1;
do
{
    echo "$i ";
    $i++; }

while ($i <= 5);
?>
```



12345

"""":a::::

c. for loop

The' for' loop is used when we know how many times we want to execute a statement or a block of statements.

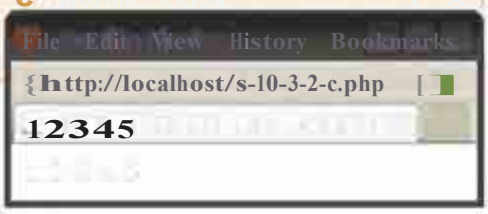
Syntax

```
for(initialization;
        condition; increment)
{  //code to be executed;
}
```

Example

(Prints natural numbers from 1 to 5)

```
<?php
   for ($i = 1;$i <= 5; $i++)
        echo "$i "; }
?>
```



e. continue and break in loops

continue is used within looping structures to skip the rest of the current loop iteration and continue execution at the condition evaluation and then begin the next iteration.

break ends execution of the current **for**, **foreach**, **while**, **do-while** or **switch** structure. **break** accepts an optional numeric argument which tells it how many nested enclosing structures are to be broken out of (like **break 1;** , **break 2;** etc.).

10.4 Arrays in PHP

An array in PHP is a collection of key and value pairs. It maps (associates) values to keys. As in C++, values contain information to be stored and keys are used to identify these values.

For example, in C++ if we write a [1] = 10; then we can say, the index '1' is the key and '10' is the value. Both key and value are allocated in a single variable and it is called an array element. In C++ we use only non negative integers as keys (or index). But in PHP we can use either non negative integers or strings as keys.

In PHP, there are three types of arrays:

- Indexed arrays
- Associative arrays
- Multidimensional

Out of this we will be discussing only indexed array and associative array.

10.4.1 Indexed arrays

Arrays with numeric index are called indexed arrays. They are almost similar to arrays in C++. They use non-negative integers as keys. These arrays can store numbers, strings and any object but their index will be represented by numbers. By default array index starts from zero. The function `array()` can be used to create an array.

Syntax for indexed arrays:

```
$array_name = array(valuel,value2,value3,etc.);
```

OR

```
$array[key] = value;
```

Example for indexed arrays:

```
$regno = array(679867, 658367, 673590);
$colors = array("red", "brown", "yellow");
```

OR

```
$regno[0] = 658367;
$regno[l] = 658367;
$regno[2] = 673590;
$colors[0] = "red";
$colors[l] = "brown";
$colors[2] = "yellow";
```

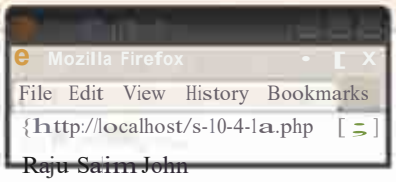
In the above example, the register numbers (679867, 658367, 673590 and "red", "brown", "yellow") are the values and the numeric characters (0, 1 and 2) are the keys of this array.

The function print_r() can be used for printing an array in a single statement. The syntax of this function is:

```
print_r(array_name);
```

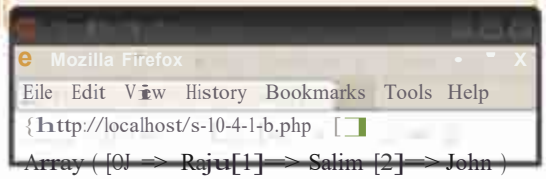
Example - Simple Array Printing

```
<?php
$Name = array ("Raju",
               "Salim", "John");
for ($i = 0; $i < 3; $i++)
    echo $Name [$i]." ";
?>
```



Example - Array printing using print_r()

```
<?php
   $Name = array ("Raju",
                  "Salim", "John");
   print_r ($Name);
?>
```



10.4.2 Associative arrays

Arrays with named keys are called associative arrays. Associative arrays are very similar to numeric arrays in terms of functionality but they are different in terms of their index. Associative arrays have their index as string.

Syntax for associative arrays:

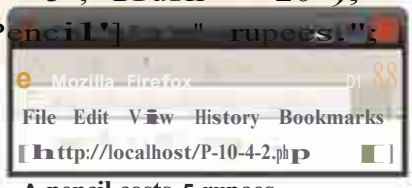
```
array(key=>value, key=>value, key=>value, etc.);
```

To store the marks of students in an array, a numerically indexed array would not be the best choice. Instead, we could use the student names as the keys in our associative array, and the value would be their respective mark.

```
$result = array("Hari" => "35", "John" => "37", "Mini" => "43");
```

Example for associative array

```
<?php
   $cost=array ("Pen"=>"35", "Pencil"=>"5", "Brush"=>"20");
   echo "A pencil costs " . $cost['Pencil'] . " rupees.";
?>
```



A pencil costs 5 rupees.

10.4.3 foreach loops

foreach loop is an extension to for loop. It is used when we have an array with unknown number of elements. It iterates through each key/value pair until the end of the array. The foreach loop works only on arrays and has two formats.

m

a. foreach ($array as $value)

In this type, for every loop iteration, the value of the current array element is assigned to $value and the array pointer is moved by one, until it reaches the last array element.

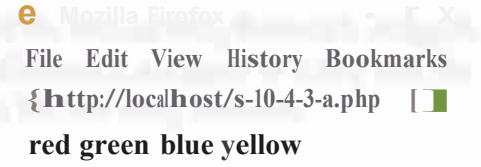
Syntax

```
foreach ($array as $value)
{
    //code to be executed;
}
```

Example

(Demonstration of foreach loop)

```
<?php
$colors = array ("red",
"green", "blue", "yellow");
foreach ($colors as $value)
{echo "$value"; }
?>
```



red green blue yellow

b. foreach (array as $key => $value)

In this type, for every loop iteration, the value of the current array element is assigned to $value and the key of the current array element is assigned to $key and the array pointer is moved by one, until it reaches the last array element.

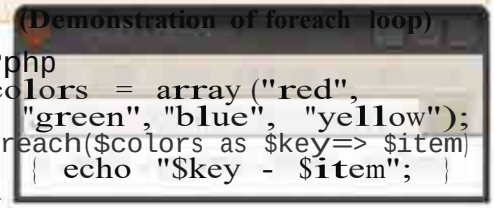
Syntax

```
foreach ($array as $key=>
                   $value)
{
    //code to be executed;
}
```

Example

(Demonstration of foreach loop)

```
<?php
$colors = array ("red",
"green", "blue", "yellow");
foreach($colors as $key=> $item)
{ echo "$key - $item"; }
2>
```



0 - red1 - green2 - blue3 - yellow

Just like other languages, in PHP we have user-defined functions and built-in functions.

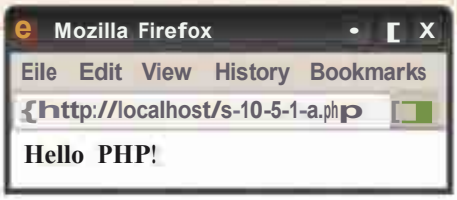
10.5.1 User-defined function in PHP

A user-defined function declaration starts with the word "function". The rules for forming function name are same as that of forming variable names in PHP. The syntax for writing a function is as follows:

```
function functionName ()
{
  //code to be executed;
}
```

Simple function

```
<?php
function hello ()
 {
   echo "Hello PHP!";
 }
 hello(); //call the function
?>
```



Function with argument and return value

```
<?php
 function add($a, $b)
   {$c =$a+ $b;
 return $c; }
 echo "5+10 =".add(5,10);
?>
```

Create an associative array containing the name and mark of 5 students and display it back (here key is 'name' and value is 'mark').

10.5.2 Built in functions

PHP comes with many useful built-in functions. Some of them are:

a. Date () function

The **PHP** date() function is used to format a date and/or a time. Its syntax is

```
date(format,timestamp)
```

The parameter 'format' specifies the format of the date and the parameter 'timestamp' which is optional specifies a timestamp. Default timestamp is the

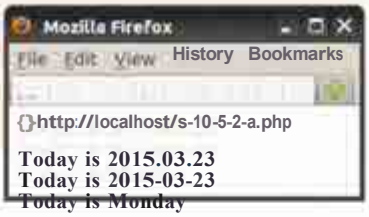
current date and time. Some characters that are commonly used for date format are:

d–day of the month (01 to 31)
m- month (01 to 12)
Y–year (in four digits)
l - day of the week

Example for date function

```
<HTML>
<BODY>
  <?php
    echo "Today is ". date("Y.m. d") . "<BR>";
    echo "Today is ". date("Y-m-d") . "<BR>";
    echo "Today is " . date("l");
  2>

</BODY>
</HTML>
```



b. String functions

chr () - The chr () function returns a character from the specified ASCII value. Its syntax is chr(ascii)

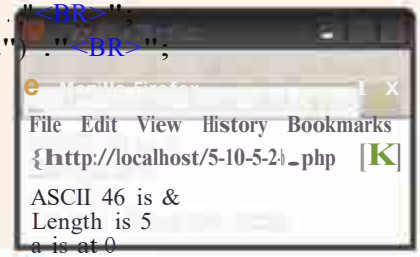
strlen () - The strlen () function returns the length of a string. Its syntax is strlen(string)

strpos () -The strpos () function finds the position of the first occurrence of a string inside another string. Its syntax is strpos (string, find, start)

strcmp () - The strcmp () function compares two strings. Its syntax is strcmp(string1,string2)

Example for string functions

```
<HTML>
<BODY>
<?php
  echo "ASCII 46 is ".chr(046) ."<BR>";
  echo "Length is ". strlen ("Apple") ."<BR>";
  echo "a is at ".strpos("apple","a") ."<BR>";
  if (strcmp("He", "She"))
    echo "He and She is not same";
  else
    echo "He and She is same";
?>
</BODY>
</HTML>
```



Know your progress

1. What is the use of array(function in PHP?
2. What are the types of loops that exist in PHP?
3. Which are the different types of arrays in PHP?
4. Which of the following are correct ways of creating an array?
   i. `state[0] = "karnataka";`
   ii. `$state[] = array("karnataka");`
   iii. `$state [OJ = "karnataka";`
   iv. `$state = array("karnataka");`
   a. iii and iv b. ii and iii c. Only i d. ii, iii and iv
5. Arrays that use string keys are called _____ .
6. What will be the output of the following code?

```
$Rent= 250;
function Expenses ($Other)
{
    $Rent= 250 + $Other;
    return $Rent;
}

Expenses(50);
echo $Rent;
```

   a. 300 b. 250 c. 200 d. Program will not compile

7. _____ function is used in PHP to return the length of a string.
8. How can we find the current date and time in PHP?

Let us do

1. Write a function in PHP to find the factorial of a number passed as parameter.
2. Write a program to display the current year

10.6 Three tier architecture in PHP

Three-tier architecture is a client-server architecture in which the functionalities like user interface, application programs, data storage etc. are separated into layers. Layers are also called 'tiers'. Even though all these tiers can be in a single machine, usually different tiers are located in physically separate computers as in Fig 10.3. In the 3-tier architecture, it is easy to modify one layer without affecting the other layer. The three tiers in the web based application development are

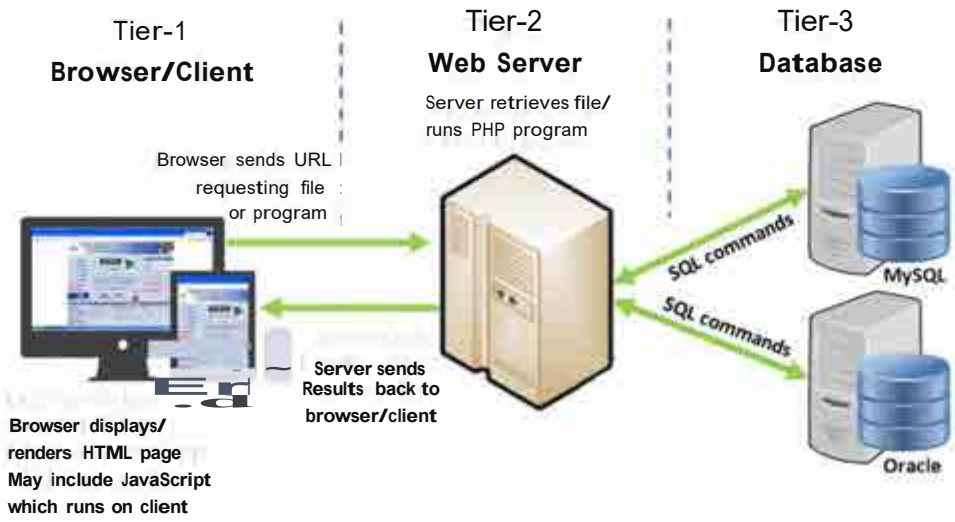


Fig 10.3: Three Tier Architecture

Tier-1: The front end in which the content is rendered by the browser. Depending on the content received by the browser from the web server, which may be HTML or HTML embedded with JavaScript, the browser generates static or dynamic page.

Tier-2: A middle, dynamic content processing and generation level containing a web server or an application server (e.g.: Apache for PHP platform). It accepts the requests from browser/client, runs the requested script and sends back the output to browser/client as HTML.

Tier-3: A back-end database or data store, comprising both data sets and the DBMS software that manages and provides access to the data (e.g.: MySQL server). The DBMS software interprets and executes the SQL commands sent from the web server and sends back the result to web server.

We have already learned HTML, MySQL and client-side scripting using JavaScript. In the next sections we will learn to connect PHP to the client and database, and construct a three tier architecture using PHP.

10.7 PHP forms

In PHP, forms are used to collect information from the client and pass it to the server. **PHP** is capable of accepting and manipulating input from all the form elements (like textbox, combobox, button etc.). In this section we will learn how the client sends information to the server, how the server acquires and works with the information submitted by client, and how the server sends back the result to the client.

Let us see an example which demonstrates the working of forms. In the following example (Figure **10.4),** the form displayed in a browser at the client side collects the register number of a student in a textbox. When the "submit" button is pressed, client sends this register number to the server. The server receives the register number and searches the database (here MySQL) for data associated with this register number. If it is found, the server creates a webpage containing the data received from the database or else server creates a webpage showing an error message (like "Wrong Register Number"). This web page is then sent back to the client.

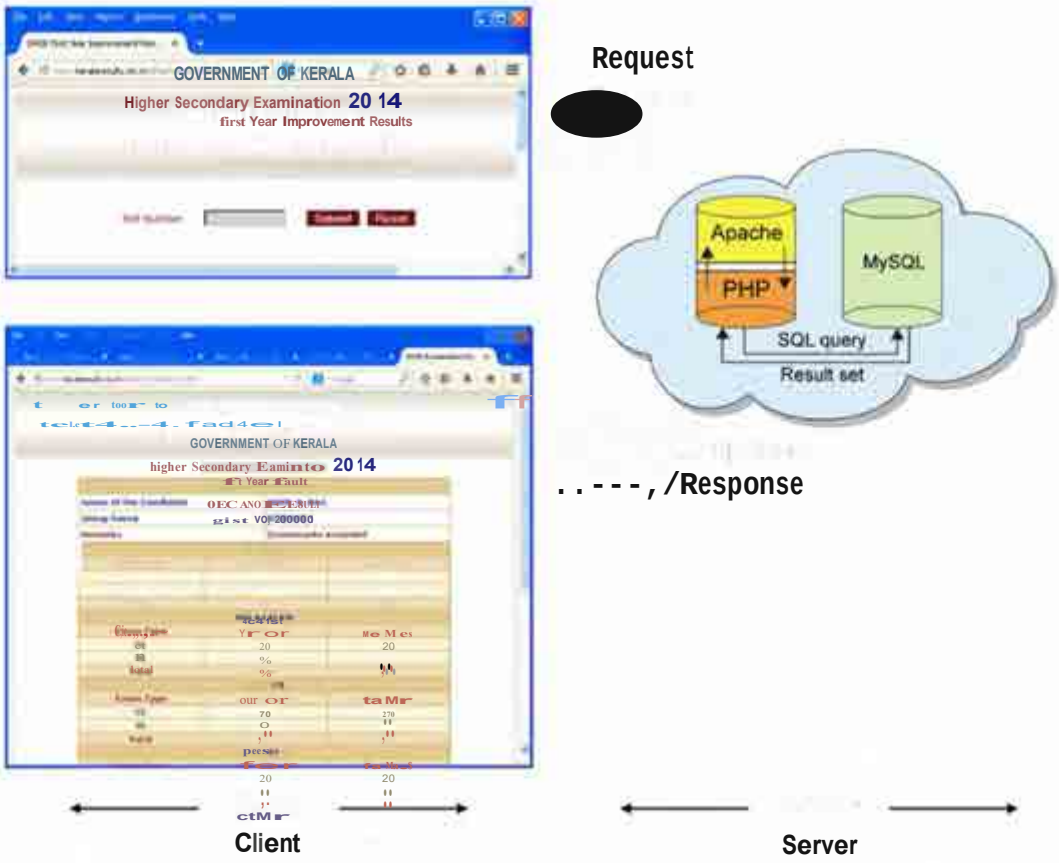


Fig : 10.4 Information flow between client and server

Before discussing how to create a form for acquiring data from the users, we need to understand global variables.

10.7.1 PHP global variables

Global variables are variables that are always accessible from anywhere in the code. Regardless of scope we can access them from any function, class or file. Usually global variables are declared in the initial part of a script and outside a function .

Superglobal arrays

PHP contains certain predefined global arrays called "superglobal". A superglobal array is a special variable that are always available in scripts, regardless of the current scope of the script. Each superglobal has a different useful purpose.

Superglobal	Description
$GLOBALS	Variables available in the global scope
$_SERVER	Information about the server
$_GET	Data passed using the HTTP GET method
$_POST	Data passed using the HTTP POST method
$_REQUEST	Data passed via an HTTP request Data
$_FILES	passed by an HTML file input Current
$_SESSION	session data specific to the user
$_COOKIE	Data stored on the user's browser as a cookie

Out of this we will discuss few essential supperglobals here.

A. PHP $GLOBALS

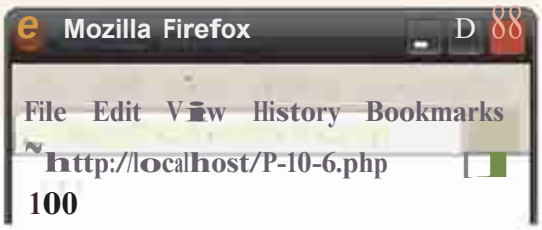
$GLOBALS is a PHP super global variable which is used to access global variables from anywhere in the PHP script. **PHP** stores all global variables in an array called $GLOBALS [index]. The index holds the name of the variable.

The example below shows how to use the super global variable $GLOBALS:

Program 10.6 to check global array

```
<?php
   $x = 75;
   $y = 25;
   function addition () {
    SGLOBALS['z'] = $GLOBALS['x'] + $GLOBALS['y'];
   }
   addition();
   echo $z;

2>
```



In the example above, since 'z' is a variable present within the $GLOBALS affaV, It Is also accessible from OutsIdC the function.

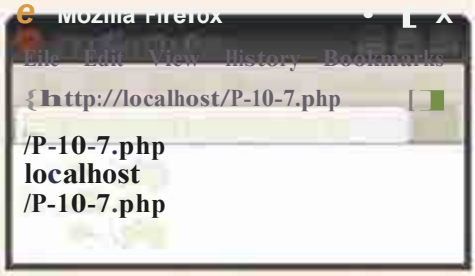
B. PHP $_SERVER

$_SERVER is a PHP super global variable which holds information about headers, paths, and script locations.

The example below shows how to use some of the elements in $_SERVER:

Program 10.7 to check $_SERVER variable

```
<?php
    echo $_SERVER['PHP_SELF'];
    echo "<BR>";
    echo $_SERVER['SERVER_NAME'];
    echo "<BR>";
    echo $_SERVER['SCRIPT_NAME'];
?>
```



The following table explains the elements inside $_SERVER used above:

Element/Code	Description
$_SERVER['PHP_SELF']	Returns the filename of the currently executing script
$_SERVER['SERVER_NAME']	Returns the name of the host server.
$_SERVER['SCRIPT_NAME']	Same as $_SERVER['PHP_SELF']

C. PHP $_REQUEST

The $_REQUEST superglobal is an array that contains the contents of the $_GET, $_POST, and $_COOKIE superglobals. It is used to collect data after submitting an HTML form.

The code in program 10.8(a) shows a form with an input field and a submit button. When a user submits the data by clicking on "Submit", the form data is sent to the file specified in the Action attribute of the <FORM> tag. Then, the super global variable $_REQUEST used in the code given in Program 10.8(b) collects the value of the input field and displays it by putting the text "Hello" in front of this value.

Hereafter we will see two program codes - an HTML code and a PHP code to illustrate the remaining concepts.

Program 10.8(a) [HTML] to check $_REQUEST variable

```
<HTML>
<BODY>
  <FORM Method="post" Action="CheckR.php">
  Name:
  <INPUT Type="text" Name="fname">

  <INPUT Type="submit" Value="Submit">
  </FORM>
</BODY>
</HTML>
```

Program 10.8(b) [CheckR.php] to check $_REQUEST variable

```
<?php
    $name = $_REQUEST['fname'];
    echo "Hello" . $name;
?>
```

D. PHP $_POST

PHP $_POST is widely used to collect form data after submitting an **HTML** form with method="post".

The example below shows a form with an input field and a submit button. When a user submits the data by clicking on "submit", the form data is sent to the file specified in the action attribute of the <FORM> tag. Then, we can use the super global variable $_POST to collect the value of the input field:

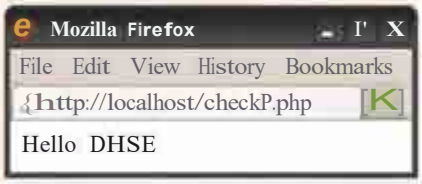
Program 10.9(a) [HTML] to check $_POST variable

```
<HTML>
<BODY>
  <FORM Method="post" Action="CheckP. php">
    Name:
    <INPUT Type="text" Name="fname">
    <INPUT Type="submit" Value= "Submit">
  </FORM>

</BODY>
</HTML>
```

Program 10.9(b) [CheckP.php] to check $_POST variable

```
<?php
   $name  =  $_POST [ 'fname'] ;
   echo  "Hello"  .  $name;
2>
```



E. PHP $_GET

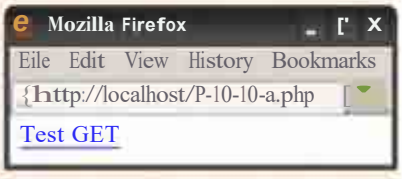
PHP $_GET is also used to collect form data after submitting an HTML form with method="get". $_GET can also collect data sent in the URL.

Try executing the example after changing the "POST" in above form (Method="post" with Method="get") and script with "GET" (Sname=$_POST ['fname'] ; with $name=$_GET ['fname'] ;)

In GET, the parameters can also be sent along with the hyperlink as in the following example.

Program 10.10(a) [HTML] to check hyperlink with parameters using $_GET

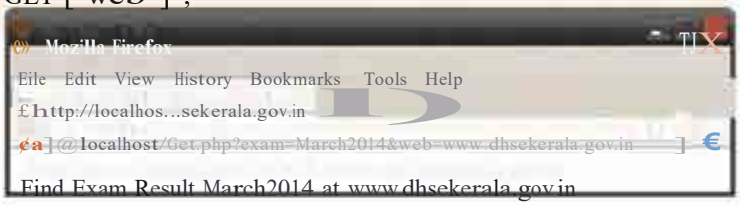
```
<HTML>
<BODY>
 <A Href="get.php?exam=March2014&web=
    www.dhsekerala.gov.in"> Test  GET</A>
</BODY>
</HTML>
```



When a user clicks on the link "Test GET", the parameters "exam" and "web" are sent to "get.php", and we can then access their values in "get.php" with$_GET.

Program 10.10(b) [Get.php] to check $_GET variable

```
<?php
    echo  "Find  Exam  Result  ". $_GET ['exam']
    echo  "  at  "  $_GET ['web'] ;
2>
```



10.7.2 GET and POST comparison

Both GET and POST are methods used to send information from a form to web server. Both creates an array (e.g. array(key1=>

value 1, key2 => value2, key3 => value3, ...)) that holds key/value pairs, where keys are the names of the form controls and values are the input data from the user.

The corresponding array names of GET and POST methods are $_GET and $_POST respectively. These are superglobals, i.e. they are always accessible, regardless of scope- and you can access them from any function, class or file without having to do anything special.

$_GET is an array of variables passed to the current script via the URL parameters.

$_POST is an array of variables passed to the current script via the HTTP POST method.

A. When to use GET?

Information sent from a form with the GET method is visible to everyone (all variable names and values are displayed in the URL). GET can send only 2000 characters. However, since the variables are displayed in the URL, it is possible to bookmark the page. GET may be used for sending non-sensitive data.

GET should never be used for sending passwords or other sensitive information!

B. When to use POST?

Information sent from a form with the POST method is invisible to others (all names/values are embedded within the body of the **HTTP** request) and has no limits on the volume of data sent. As this method is secure, most developers prefer POST for sending form data. However, since the variables are not displayed in the URL, it is not possible to bookmark the page.

Method= GET	Method= POST
The data remains visible in the address bar since contents are passed as part of the URL	The data is not visible as contents are passed to the script as an input file.
Page link can be bookmarked.	Page link can never be book marked.
Data is submitted as part of the URL.	Data is submitted as part of an http request.
Data sending is fast but not secure.	Data sending secure but slow as compared to get.
GET can only send 2000 characters.	No limit.

Project

Now we know how a form collects data from the user/client, how it submits (sends) it to the server and how the server sends the result back to user/client. Let us consolidate this by executing a project which would demonstrate what we have learned regarding web based programming.

Create a form which accepts the register number, name and marks (out of 100) in three subjects and submit it to the server. The script at the server should receive the data, calculate the result and send it back to the client. To pass the examination a student should get a minimum of 40 marks in each subject. If the total marks < 150 it is "Passed", total marks >= 150 and < 180 it is "Second Class", if total marks >= 180 and < 225 it is "First Class" and if total marks >= 225 it is "Distinction".

Program 10.11(a) [HTML] Form to accept student data

```
</HTML>
</BODY>
   <FORM  Method="post"  Action="Resul t. php">
      Register  No:
      <INPUT  Type="text"  Name="regno">  <BR>
      Name.....:
      <INPUT  Type="text"  Name="sname">  <BR>
      Mark-1.....:
      <INPUT  Type="text"  Name="markl">  <BR>
      Mark-2.....:
      <INPUT  Type="text"  Name="mark2">  <BR>
      Mark-3.....:
      <INPUT  Type="text"  Name="mark3">  <BR>
      <INPUT  Type="submit"  Value="Show  Result">
   </FORM>
</BODY>
</HTML>
```

Program 10.11(b) [Result.PHP] Script which displays the result

```
<?php
   $m1 = $_POST ['mark1'];
   $m2 = $_POST ['mark2'] ;
   $m3 = $_POST ['mark3'];
   $tmarks = $m1 + $m2 + $m3;
   if ( ($m1<40) || ($m1<40) || ($m1<40))
       $result = "Failed";
   elseif ($tmarks < 150)
       $result = "Passed";
   elseif ($tmarks < 180)
       $result = "Second Class";
   elseif ($tmarks < 225)
       $result = "First Class";
   else
       $result = "Distinction";
   echo "<BR> Register No. : " . $_POST ['regno'];
   echo "<BR> Name ..... : " . $_POST ['sname'];
   echo "<BR> Total Marks.: " . $tmarks;
   echo "<BR> Result ..... : " . $result;
?>
```

Let us do

Create an HTML form that accepts a register number and submits to "display.php". The display.php displays the received register number on the browser.

Execute the above with the GET method and

a. Note down the URL in address bar of the browser, after submitting the form.

b. Bookmark the form after submitting and try to recall the form from bookmark.

Change the method to POST and repeat the above steps.

10.8 Connecting PHP to database (MySQL)

Static web pages (normal pages we build) always look the same and the content never changes unless we load a new page. Dynamic pages do the opposite, they change every time they are loaded and they can change their content based on what users do, like clicking on some button, text or an image. A dynamic website creates

a new web page each time when someone requests information. These web pages are automatically built by the web server by pulling information from the database into a web page template upon request and send a standard HTML page back to the browser. The web server builds this webpage by following the instructions written using a server side scripting language, by the programmer.

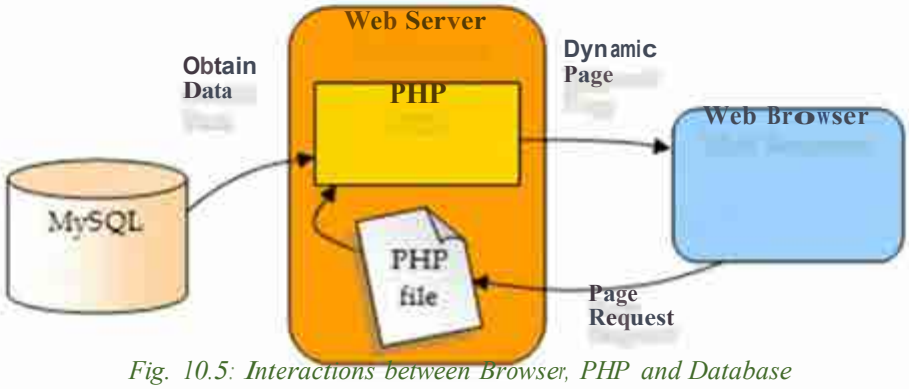


Fig. 10.5: Interactions between Browser, PHP and Database

One example of a database-driven Web site is "keralaresults.nic.in" discussed in the previous section (see Figure 10.5). This is one of the many websites that publishes the higher secondary examination results. The site's server contains a database which stores the examination results of all candidates who appeared for their examination in an academic year. When the register number is submitted through a form (client side), it reaches the web server. The web server hands this over to the PHP program. The PHP program requests the database server for data associated with this register number through an SQL statement (like SELECT* FROM marks WHERE regno = 2056789). Database server searches and finds the data (examination result) for this register number from the database and returns it back to PHP. PHP prepares a neatly formatted web page using HTML and embeds the data retrieved in it. This newly created web page is sent back to the client by the web server.

From the discussions in the previous chapters (database management and SQL), we know how to interact with the database using SQL statements. In this section, we will learn to do the same through a PHP program and to combine the retrieved data with HTML to create dynamic web pages.

10.8.1 Establishing connection to MySQL database

For a **PHP** program to access data from the database, the program should first establish a connection to the database server (here MySQL) and then specify the database to use. Only after this will PHP program be able to issue SQL queries to the database.

Connection to a MySQL database is done in three steps

1. Open a connection to MySQL.
2. Specify the database we want to open.
3. Retrieve data from or insert data in to database.
4. Close the connection.

Step 1- Open a connection to MySQL

mysql_connect () function is used to establish a connection between PHP and MySQL database server. It takes three string arguments, the host/ server name, the username, and the password. The function returns a link identifier when it successfully connects to the specified MySQL server or NULL up on error.

```
$link_id = mysql_connect ("local host", "User ID", "Password");
```

Program 10.12 [Connect.PHP] script to demonstrate connection to MySQL

```
<?php
 $user_name = "root"; //Initialising variables
 $password = "root";
 $server = "localhost";
 //Connecting to MySQL database server
 $db_handle = mysql_connect ($server, $user_name, $password);
 if (!$db_handle) {
    die ('Could not connect: ' . mysql_error());
 }
 echo 'Connected successfully';
 mysql_close($db_handle);
?>
```

In Program 10.12, first three lines are for setting up variables. In this example the username and password is "root".

```
$user_name = "root";
$password = "root";
$server = "localhost";
```

The line that connects to MySQL is

```
mysql_connect($server, $user_name, $password);
```

The parameters to mysql_connect can also be given directly as in the following statement

```
mysql_connect( 'localhost', 'root', 'root' );
```

Try executing the example above with wrong password and note down the output.

Step 2 - Specify the database you want to open

The MySQL database server may contain a lot of databases. mysql_select_db () function is used to select a particular MySQL database from them. It takes a string which is the database name and a link identifier as argument. If it finds the database, it returns **true**; or else, **false** is returned.

```
mysql_select_db($database);
```

Program 10.13 [DBConnect.PHP] Script to demonstrate connection to Database

```
<?php
 $user_name = "root";
 $password = "root";
 $server = "localhost";
 $database = "mysql"; //initializing variable
 $db_handle = mysql_connect ($server, $user_name, $password) ;
 if (!$db_handle) {
      die ('Could not connect: ' . mysql_error());
 }
 echo 'Connected successfully';
 //Opening the database mysql
 $db_found = mysql_select_db ($database) ;
 if ($db_found) {
      echo "Database Found";
 }
 else {
      echo "Database NOT Found";
 }
 mysql_close($db_handle);
?>
```

Here we assigned a variable named $database with the name of our database, using the statement.

```
$database= "mysql";
```

and opened the database with the statement.

```
$db_found = mysql_select_db ($database);
```

Here it assumes that the connection to use is the currently active connection. The following statement can also be used for opening the database when we have to use a different connection. Here the resource link identifier of the connection to be used goes as the second parameter.

```
$db_found = mysql_select_db ($database, $db_handle);
```

We have connected to the server and selected the database we want to work with. Now we have to start querying the database and create dynamic webpages.

Step 3 - Reading data from database

Reading data from the database is done in two steps.

a. Execute the SQL query on the database using the function mysql_query ().

b. Populate the rows in to an array using the function mysql_fetch_array ().

This array is used by the **PHP** program for manipulating the data.

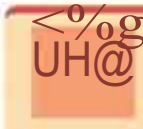
a. mysql_query()

The function mysql_query () is used to execute the SQL query on database. It sends the query to the database and returns a resource type query handle on successful execution.

```
$result_set = mysql_query(query, connection)
```

- For the SQL statements SELECT, SHOW, DESCRIBE or EXPLAIN, mysql_query () returns a resource type query handle on success, or FALSE on error.
- For other type of SQL statements, UPDATE, DELETE, DROP, etc, mysql_query() returns TRUE on success or FALSE on error.
- mysql_query0 will also fail and return FALSE if the user does not have permission to access the table(s) referenced by the query.

The returned result resource is passed to mysql_fetch_array () to retrieve data.



Usemys!_num_rows0 to find how many rows were returned for a SELECT statement or mysq!_affected_rows0 to find out how many rows were affected by a DELETE, INSERT, REPLACE, or UPDATE statement.

b. mysql_fetch_array()

The `mysql_fetch_array()` is used to populate rows of data as an array from a MySQL result handle. It takes a result handle returned from `mysql_query()`, as parameter, and returns an array corresponding to the fetched row. The array can be an associative array, a numeric array, or both. If there are no more rows left to fetch, itreturns `False`.

```
$result_set = mysql_query (query, connection) ;
$fetched_row = mysql_fetch_array ($result_set) ;
```

Try executing Program 10.13 with a non existing database name, and note down the output.

The working of these two functions can be explained with the help of two examples given below.

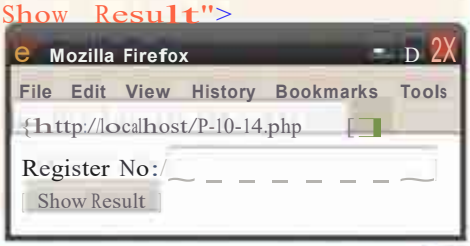
The following program (Program 10.14) accepts a register number using a form and submits it to showmarks.php. The PHP program searches the marks table in mysql database, finds the data and creates a webpage containing this data.

Field name	Data Type
regno	Number
sname	Char(20)
sgroup	Char(20)
mark1	Number
mark2	Number
mark3	Number

Note : Before doing the programs Program 10.14 and Program 10.15 listed below, create a table named "Marks" with the following structure in the database named "mysql" and insert a few records into it (Group name should be either Commerce/Science).

Program 10.14(a) [HTML] Form to accept student register number

```
<HTML>
<BODY>
   <FORM Method="post" Action="showmarks .php">
      Register No:
      <INPUT Type="text" name="regno"> <BR>
      <INPUT Type="submit" Value="Show Result">
   </FORM>
</BODY>
</HTML>
```



Program 10.14(b) [Showmarks.PHP] Script to search the database and display the result

```
<?php
$user_name = "root";
$password = "root";
$server = "localhost";
$database = "mysql";
$regno = $_POST['regno'];
$db_handle = mysql_connect($server, $user_name, $password);
if (!$db_handle) {
    die("Could not connect: " . mysql_error());}
$db_found = mysql_select_db($database, $db_handle);
if ($db_found) { //Retrieving data from database
    $SQL ="SELECT* FROM marks WHERE regno = '".$regno."'";
    $result_set = mysql_query($SQL);
    $record = mysql_fetch_array($result_set);
    echo "<BR>MARK LIST";
    echo "<BR>=========",
    echo "<BR>Reg. No.:". $record['regno'];
    echo "<BR>Name ....: ". $record['sname'];
    echo "<BR>Group ...: ". $record['sgroup'];
    echo "<BR>Mark-1.. :". $record['mark1'];
    echo "<BR>Mark-2.. :". $record['mark2'];
    echo "<BR>Mark-3.. : ". $record['mark3'];
    echo "<BR>Result .. : ". compute_result($record['mark1'],
                    $record['mark2'], $record['mark3']);
  }
else
  {echo "<BR>Database NOT Found";}
mysql_close($db_handle);
//Function to calculate result
function compute_result($m1, $m2, $m3)
{  $tmarks = $m1 + $m2 + $m3;
    if (($m1<40) || ($m1<40) || ($m1<40))
          $result = "Failed";
    elseif ($tmarks < 150)
          $result = "Passed";
    elseif ($tmarks < 180)
          $result = "Second Class";
    elseif ($tmarks < 225)
          $result = "First Class";
    else
          $result = "Distinction";
return $result;
?>
```

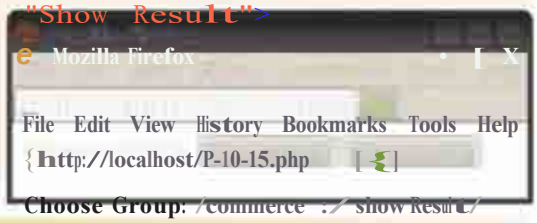
Observe the code enclosed in the rectangle. This portion is responsible for getting data from the database. Here a variable named $SQL is initialised with the query statement we want to execute. The next statement mysql_query ($SQL) executes the query statement and returns the result which is stored to the variable $result_set. This $result_set is passed to mysql_fetch_array ($result_set), which returns an associative array created using the data provided by the $result_set. The array returned by the function is stored in the variable $record and its content is accessed by specifying the field name as index, like $record['sname'].

Let us see another program which (Program 10.15) allows us to select a group (science/commerce) using a combo box in a form and displays the result of students studying in that group in a table format.

Program 10.15(a) [HTML] Form to accept the group

```
<HTML>
<BODY
>
   <FORM Method="post" Action=" showresult. php">
   Choose Group:
   <SELECT Name= "cgroup">
      <OPTION>Science</OPTION>
      <OPTION>Commerce</OPTION>
   <INPUT Type="submit" Value= "Show Result">
   </FORM>

</BODY>
</HTML>
```



Program 10.15(b) [showresult.PHP] Script to search the database and display the result

```
<?php
   $user name = "root";
   $password = "root";
   $server = "localhost";
   $database = "mysql";
   $db_handle = mysql connect($server,$user name,$password);
   if (!$db_handle) {
      die ('Could not connect: ' . mysql error () ) ;
   }
   $db_found = mysql select db ($database, $db handle);
   if ($db found)
   {
```

```
    $SQL ="SELECT* FROM marks WHERE sgroup =
                                        '".$ POST[cgroup] "'";
    $select_query = mysql query ($SQL);
    echo "<TABLE Border= 1">;
    echo "<TR>";

    echo "<TH Colspan="7"><CENTER> MARK LIST </CENTER> </TH>";
    echo "</TR>";
    echo "<TR>";
    echo "<TD>Reg No</TD>";
    echo "TD>Name</TD>";
    echo "<TD>Group</TD>";
    echo "<TD>Mark-1</TD>";
    echo "<TD>Mark-2</TD>";
    echo "<TD>Mark-3</TD>",
    echo "<TD>Result</TD>",
    echo "</TR>";
    while($record mysql fetch_array($select query)) {
        echo "<TR>";
        echo "<TD>" $record['regno'] "</TD>";
        echo "<TD>" $record['sname'] "</TD>";
        echo "<TD>" $record['sgroup'] "</TD>";
        echo "<TD>" $record['mark1'] "</TD>";
        echo "<TD>" $record['mark2'] "</TD>";
        echo "<TD>" $record['mark3'] "</TD>";
        echo "<TD>" compute_result ($record['mark1'],
              $record['mark2'], $record['mark3']). "</TD>";
        echo "</TR>";
    }
    echo "</TABLE>";

else
    echo '<BR>Database NOT Found';
}
mysql close($db handle);
//Function to calculate result
function compute result ($m1, $m2, $m3)
{   $tmarks = $m1 + $m2 + $m3;
    if ( ($m1<40) || ($m1<40) || ($m1<40))
            $result ="Failed";
    elseif ($tmarks < 150)
            $result ="Passed";
    elseif ($tmarks < 180)
            $result =" Second Class";
    elseif ($tmarks < 225)
            $result =" First Class";
    else
            $result "Distinction";

return $result;
  ?>
```

F'''Oill

"""":a:"""

Observe the code enclosed in the rectangle. This portion is responsible for displaying the data from the database in a tabular format. To display the data in a tabular format, the data received through mysql_fetch_array(Sresult_set) is arranged using <TABLE> tag. During each iteration of while loop, a new row is added to the table using the <TR> </TR> tag and the data in the associative array is placed in proper columns using <TD> </TD> tag. Each iteration of the loop mysql_ fetch array ($result set) loads $result with new data. Once reading is complete the function returns false and loop exits.

Step 4- Close the connection

mysql_close () is used to close a connection to the database server. The link to the MySQL server is automatically closed when the PHP script is terminated. If we want to close the connection before the termination of the PHP script, this function is used with the link identifier as its argument.

```
mysql_close($db_handle);
```

This function returns True on success and False on error.

See the statement mysql_close ($db_handle) ; in the previous examples.

As too many open MySQL connections can cause problems, it is a good practice to close the MySQL connection once all the queries are executed.

10.8.2 Creating a new table using PHP

To create a new table, prepare and execute an SQL statement for creating the table using mysql_query () function. An example for this is

```
$SQL = "CREATE TABLE marks (regno number,tname char(20),
      m1 number,m2 number,m3 number,distinction char(20))";
$select_query = mysql_query ($SQL);
```

10.8.3 Inserting data into a table using PHP

To insert data into table we have to prepare an insert SQL statement and execute it using mysql_query () function. Assume that $sregno, $sname, $sm1, $sm2, $sm3 and $sresult contains the data to be inserted. The SQL statement to insert will look like

```
$SOL = "INSERT INTO marks VALUES (".$sregno.", ".Ssname.
          "', ". $sm1. ", ". $sm2. ", ". $sm3. ", '". $sresult."') ";
$select_query = mysql_query ($SQL);
```

10.8.4 Updating data in a table using PHP

To update data in a table, we have to prepare an update SQL statement and execute it using mysql_query () function. Assume that we want to change mark 'm1' of the register number in the variable $tregno to '70'. The SQL statement for updating will look like

```
$SQL = "UPDATE marks SET m1=70 WHERE regno='".$sregno."'";
$select_query = mysql_query($SQL);
```

us conclude

Dynamic webpages are created with the help of server side scripting languages like PHP, Perl, JSP, ASP NET, etc. Out of various server side scripting languages PHP is the most popular. PHP can run on various web severs and operating systems. With the help ofHTML and database like MySQL, PHP can create powerful dynamic web pages and it is easy to learn as it follows the syntax ofthe language C++.

'et s »race

1. Write a PHP program to display the multiplication table of 5.
2. Write a PHP program to display all palindrome numbers between 100 and 200.
3. Write a PHP program to display all Armstrong numbers below 1000.
4. Display the following table using PHP and HTML. Each cell should display the row number and column number of the cell. You are supposed to use the PHP loop statement to generate the table.

Column 1	Column 2	Column 3	Column 4	Column 5
row 1, col 1	row 1, col 2	row 1, col 3	row 1, col 4	row 1, col 5
row 2, col 1	row 2, col 2	row 2, col 3	row 2, col 4	row 2, col 5
row 3, col 1	row 3, col 2	row 3, col 3	row 3, col 4	row 3, col 5
row 4, col 1	row 4, col 2	row 4, col 3	row 4, col 4	row 4, col 5
row 5, col 1	row 5, col 2	row 5, col 3	row 5, col 4	row 5, col 5
row 6, col 1	row 6, col 2	row 6, col 3	row 6, col 4	row 6, col 5
row 7, col 1	row 7, col 2	row 7, col 3	row 7, col 4	row 7, col 5
row 8, col 1	row 8, col 2	row 8, col 3	row 8, col 4	row 8, col 5
row 9, col 1	row 9, col 2	row 9, col 3	row 9, col 4	row 9, col 5
row 10, col 1	row 10, col 2	row 10, col 3	row 10, col 4	row 10, col 5

5. Write a program to find the biggest of three numbers.
6. Create a registration form which contains the fields Name, Roll No, Gender and a submit button. Write a PHP script which accepts these details and display it back on the browser when the user clicks the submit button.
7. Write a PHP script for the following: Design a form to accept a string. Write a function to count the total number of vowels (a,e,i,o,u) from the string.
8. Create a table in MySQL and insert a few records. Write a PHP script to display the inserted records on a browser.
9. Create a table in MySQL and insert a few records. Write a PHP script to accept a value using a form, search the value in database and display the record on a browser.

Let us assess

1. Which of following functions returns 1 when the output is successful?
   a. echo() b. print () c. both d. None
2. Which of the following printing constructs accepts multiple parameters?
   a. echo b. print c. printf d. All of the above
3. Which one of the following should not be used while sending passwords or other sensitive information?
   a.GET b.POST c. REQUEST d. NEXT
4. Which of the following functions returns the number of characters in a string variable?
   a. count($variable) b. len($variable)
   c. strcount($variable) d. strlen($variable)
5. Which of the following variables is not a predefined variable?
   a. $GET b. $ASK c. $REQUEST d. $POST
6. When $_GET variable is used to collect data, the data is visible to
   a. none b. only you c. everyone d. selected few
7. When $_POST variable is used to collect data, the data is visible to
   a. none b. only you c. everyone d. selected few
8. Which variable is used to collect form data sent with both the GET and POST methods?
   a.$BOTH b. $_BOTH c. $REQUEST d. $_REQUEST
9. Which one of the following parameters is not used in mysql_connect()?
   a. database host b. user ID c. password d. database name

10. Study the following steps and determine the correct order
    i. Open a connection to MySQL server
    ii. Execute the SQL query
    iii. Fetch the data from query
    iv. Select database
    v. Close Connection
    a. 1,4,2,3,5 b. 4, 1, 2, 3, 5 c. 1, 5, 4, 2, 1 d. 4, 1, 3, 2, 5
11. What is PHP?
12. What is the difference between PHP and JavaScript?
13. What are the steps involved in running a PHP?
14. What is the use of "echo" in PHP?
15. What is the use of 'print' in PHP?
16. What are the differences between "echo" and "print" statements?
17. Why is PHP superior to client-side languages such as JavaScript?
18. Which character is used to terminate a PHP statement? Name one situation where omitting this termination character does not produce an error.
19. What is an escape sequence? Name three commonly used escape sequences.
20. What will be the output of the following PHP scripts?

    a.
```
<?php
echo "Today looks\nbright and sunny";
?>
```

    b.
```
<?php
echo "Ours not to question why;";
echo "Ours but to do and die";
?>
```

    c.
```
<?php
$x = 8;
$y = 8;
echo ($x == $y) ;
?>
```

21. Find the error in each of the following PHP scripts:

a.
```
<?php
/* print a line of output/
echo 'Hello'
2>
```

b.
```
<?php
echo '<p align="right">Copyright Me, 2008</p>';
?>
```

c.
```
<?php
echo 'Line 1;
?>
```

22. Which are the different types of loops in PHP?

23. How do we declare an array in php?

24. What is the importance of "action" attribute in an HTML form?

25. How can we extract the string "hotmail.com" from a string "scert@hotmail.com"?

26. What will be the output of the following code?

```
$a= 10;
if ($a > 5 or < 15)

        echo 'true';
else
        echo 'false';
```

27. What will be the output of the following code?

```
function fn ($var)
{

$var = $var - ($$var/1O5);
return $var;
}

echo fn(100);
```

28. How do super-global arrays help programming in **PHP**?

29. What is the use of $_SERVER?

30. What are the differences between GET and POST methods in form submitting?

31. While submitting a form, the URL displayed on the address bar was http://localhost:8080/check:2.php?exam=March2014&w eb=www. dhsekerala.gov.in. Can you identify which method was used here?

32. While trying to open a dynamic webpage from a bookmark saved earlier, the webpage did not show properly. What could be the reason for this?

33. How do we create a MySQL connection?

34. How do we select a MySQL database from PHP?

35. How do we execute an SQL query? How to fetch its result?

36. What is the difference between PHP and JavaScript?

37. Explain the procedure for connecting PHP with MySQL.

GI Advances in Computing

EIRE

After the completion of this chapter, the learner

- recalls serial computing.
- identifies different distributed computing paradigms.
- compares serial computing and parallel computing.
- distinguishes between cluster computing and grid computing.
- identifies the cluster computing techniques.
- recognises the need of grid computing.
- analyses the need of cloud computing models.
- explains the role of artificial intelligence in modern day computing.
- identifies the use of biometric equipment in service sectors.
- explains the relevance of computer vision by citing the examples.
- identifies the scope of robotics.
- explains bioinformatics and its relevance in the medical field.
- describes remote sensing and its application areas.
- judges the need of GIS.

The growing popularity of the Internet and the availability of powerful computers and high-speed networks with low-cost components have been changing the way of computing. We know that the computing world is constantly changing and requires the use of new technologies to solve emerging real world problems. In this chapter, we will discuss advanced computing paradigms to meet the ever changing computing needs in various fields. The distributed computing system uses multiple computers to solve large-scale problems over the Internet. It becomes data-intensive and network-centric. Nowadays, applications of distributed computing have become increasingly widespread. In distributed computing, the main stress is on large scale resource sharing and always goes for the best performance. Social media sites like Facebook, Twitter, etc., search engine websites like Google, Bind, etc. are implemented on the concept of largely distributed computing systems. These are running in centrally controlled data centers. However, the trend in these massively scalable systems is making use of advanced computing models like cluster, grid, cloud, etc. A brief discussion of all these areas wil be made in this chapter.

Computational intelligence is an area where a lot of research is going on. An intelligent computer should be able to interact with human beings. Cybernetics is the study of the interaction between humans and machines. Artificial intelligence was always an area of immense curiosity. Many technologies such as biometrics, Natural Language Processing (NLP), robotics, etc. implement artificial intelligence in varying degrees. Computers are known for accuracy both in accepting input and providing output. In this chapter we also discuss another area of computing called soft computing, which is tolerant of imprecision, uncertainty, partial truth and approximation. Like any other subject, Biology also received contributions from developments in computing. Bioinformatics is the application of computer technology to the management of biological information. Scientists are keen on developing DNA computing which may change the world for the better. These topics are also discussed here. This chapter concludes with the discussion on remote sensing and Geographical Information Systems (GIS).

11.1 Distributed computing paradigms

Historically, the field of computing has gone through a series of changes in hardware, operating system platforms, networking, etc. Computers have become very much part of our daily lives. Distributed computing ensures that computer systems are used effectively. Distributed computing is a method of computer processing in which different parts of a program are run simultaneously on two or more computers that are communicating with each other over a network.

The term paradigm means a pattern or a model in the study of any subject of complexity. We can identify and classify the details of the subject in accordance with these models. Advanced computing paradigms are essential to extend our ability to process information for many sectors of our society. Advanced computing paradigms include parallel computing, cluster computing, grid computing, cloud computing, etc. All these are various forms of parallel and distributed computing which are discussed below.

11.2 Distributed computing

Let us now consider a real world case where we use distributed computing. We know that banks follow the core banking system. As a result of this, money can be withdrawn from any Automatic Teller Machine (ATM) counter. Similarly we can book railway or airline tickets online. All these are possible by making use of the distributed computing environment. World Wide Web (WWW) is the best example of a large distributed system. Nowadays distributed systems dominate the computing environment.

Distributed computing is a method of computing in which large problems can be divided into many small problems which are distributed to many computers. Later, all the small results are assembled to get the desired overall solution. Distributed computing provides a way to reduce the time it takes to perform a large task. It is accomplished by dividing the task among multiple computers that can work simultaneously. Distributed computing completes the job in time less than what a single machine requires. Distributed computing is a method of computing in which different parts of a program are run simultaneously on two or more computers that are communicating with each other over a network.

In distributed computing, all the different processors have their own private non-sharable memory. Thus information is exchanged between the processors solely on the basis of messages. Figure 11.1 shows a distributed computing architecture.

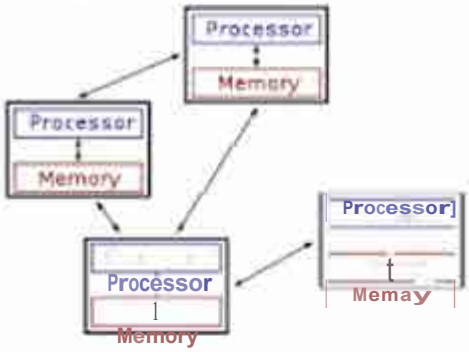


Fig. 11.1: Distributed computing

a. Advantages

The advantages of distributed computing are given below.

Economical: Distributed computing reduces overall computing cost.

Speed: By spreading the computational load across different nodes, each location is under less stress, as a result of which speed increases.

Reliability: Distributed systems can continue to function even if one node ceases to function.

Scalability: In distributed computing the number of nodes can vary according to the demand.

b. Disadvantages

The limitations of distributed computing are listed below.

Complexities: A lot of extra programming is required to set up a distributed system.

Security: Information needs to be passed to the computers in the network. It can be tracked and can be used for illegal purpose.

Network reliance: Distributed system is connected through a network and in case of network failure, the entire system may become unstable.

Let us now discuss various types of distributed computing.

11.2.1 Parallel computing

Traditionally, a software has been written for serial computation. i.e., it is to be run on a single computer having a single processor. Here a problem is broken into a series of instructions. Instructions are to be executed one by one sequentially. Only one instruction is executed at a time. It is referred to as serial computing. Fig.11.2 shows serial processing.

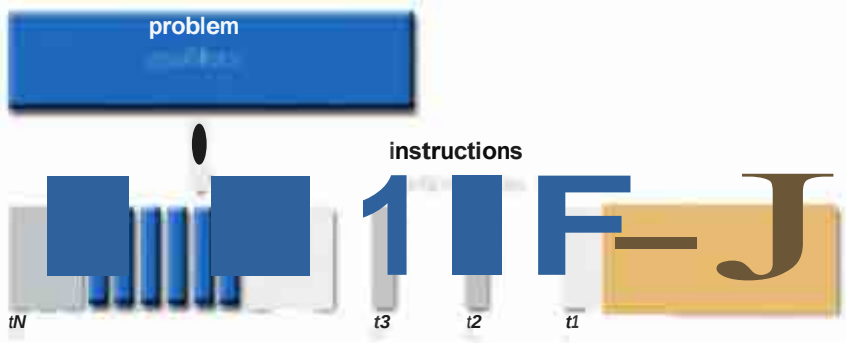


Fig. 11.2: Serial processing

Suppose there are five men lifting a rock with a single rope. Here all of them are trying to lift the rope in parallel. Similarly in parallel computing a problem is solved by different processing units. The problem will be subdivided among the various CPUs. Parallel computing is a form of computation in which many calculations are carried out simultaneously, operating on the principle that large problems can often be divided into smaller ones, which are then solved concurrently (in parallel). There are several different forms of parallel computing: bit-level, instruction level, data, and task parallelism. Parallelism has been employed for many years, mainly in high-performance computing, but interest in it has grown lately due to the physical constraints preventing frequency scaling. As power consumption (and consequently heat generation) by computers has become a concern in recent years, parallel computing has become the dominant paradigm in computer architecture, mainly in the form of multi-core processors.

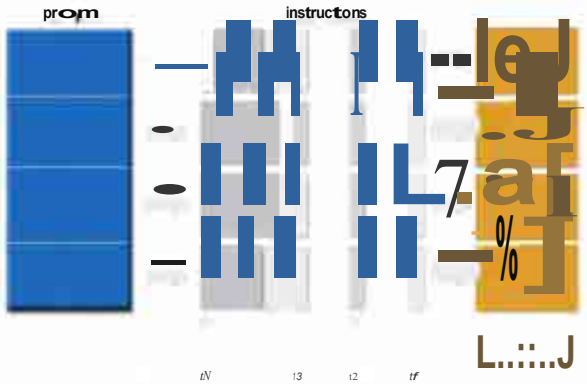


Fig.11.3: Parallel processing

In computer science, parallel computing is the simultaneous execution of some combination of multiple instances of programs, using more than one processor. Parallel computing is closely related to concurrent computing—they are frequently used together, and often conflated, though the two are distinct: it is possible to have parallelism without concurrency (such as bit-level parallelism), and concurrency without parallelism (such as multitasking by time-sharing on a single-core CPU). In parallel computing, a computational task is typically broken down in several, often many, very similar subtasks that can be processed independently and whose results are combined afterwards, upon completion. In contrast, in concurrent computing, the various processes often do not address related tasks; when they do, as is typical in distributed computing, the separate tasks may have a varied nature and often require some inter-process communication during execution.

Parallel computers can be roughly classified according to the level at which the hardware supports parallelism, with multi-core and multi-processor computers having multiple processing elements within a single machine, while clusters, MPPs, and grids use multiple computers to work on the same task. Specialized parallel computer architectures are sometimes used alongside traditional processors, for accelerating specific tasks.

Parallel computer programs are more difficult to write than sequential ones, because concurrency introduces several new classes of potential software bugs, of which race conditions are the most common. Communication and synchronization between the different subtasks are typically some of the greatest obstacles to getting good parallel program performance. The maximum possible speed-up of a single program as a result of parallelization is known as Amdahl's law.

Background

Traditionally, computer software has been written for serial computation. To solve a problem, an algorithm is constructed and implemented as a serial stream of instructions. These instructions are executed on a central processing unit on one computer. Only one instruction may execute at a time—after that instruction is finished, the next is executed.

Parallel computing, on the other hand, uses multiple processing elements simultaneously to solve a problem. This is accomplished by breaking the problem into independent parts so that each processing element can execute its part of the algorithm simultaneously with the others. The processing elements can be diverse and include resources such as a single computer with multiple processors, several networked computers, specialized hardware, or any combination of the above.

Frequency scaling was the dominant reason for improvements in computer performance from the mid-1980s until 2004. The runtime of a program is equal to the number of instructions multiplied by the average time per instruction. Maintaining everything else constant, increasing the clock frequency decreases the average time it takes to execute an instruction. An increase in frequency thus decreases runtime for all compute-bound programs. However, power consumption by a chip is given by the equation $P = C \times V^2 \times F$, where P is power, C is the capacitance being switched per clock cycle (proportional to the number of transistors whose inputs change), V is voltage, and F is the processor frequency (cycles per second). Increases in frequency increase the amount of power used in a processor. Increasing processor power consumption led ultimately to Intel's May 2004 cancellation of its Tejas and Jayhawk processors, which is commonly cited as the end of frequency scaling as the dominant computer architecture paradigm.

Moore's Law is the empirical observation that the number of transistors in a microprocessor doubles every 18 to 24 months. Despite power consumption issues, and repeated predictions of its end, Moore's law is still in effect. With the end of frequency scaling, these additional transistors (which are no longer used for frequency scaling) can be used to add extra hardware for parallel computing.

Amdahl's law and Gustafson's law

Optimally, the speed-up from parallelization would be linear—doubling the number of processing elements should halve the runtime, and doubling it a second time should again halve the runtime. However, very few parallel algorithms achieve optimal speed-up. Most of them have a near-linear speed-up for small numbers of processing elements, which flattens out into a constant value for large numbers of processing elements.

The potential speed-up of an algorithm on a parallel computing platform is given by Amdahl's law, originally formulated by Gene Amdahl in the 1960s. It states that a small portion of the program which cannot be parallelized will limit the overall speed-up available from parallelization. A program solving a large mathematical or engineering problem will typically consist of several parallelizable parts and several non-parallelizable (serial) parts. If the non-parallelizable part of a program accounts for 10% of the runtime ($P = 0.9$), we can get no more than a 10 times speed-up, regardless of how many processors are added. This puts an upper limit on the usefulness of adding more parallel execution units. "When a task cannot be partitioned because of sequential constraints, the application of more effort has no effect on the schedule. The bearing of a child takes nine months, no matter how many women are assigned."

Amdahl's law only applies to cases where the problem size is fixed. In practice, as more computing resources become available, they tend to get used on larger problems (larger datasets), and the time spent in the parallelizable part often grows much faster than the inherently serial work. In this case, Gustafson's law gives a less pessimistic and more realistic assessment of parallel performance.

Dependencies

Understanding data dependencies is fundamental in implementing parallel algorithms. No program can run more quickly than the longest chain of dependent calculations (known as the critical path), since calculations that depend upon prior calculations in the chain must be executed in order. However, most algorithms do not consist of just a long chain of dependent calculations; there are usually opportunities to execute independent calculations in parallel.

Let P_i and P_j be two program segments. Bernstein's conditions describe when the two are independent and can be executed in parallel. For P_i, let I_i be all of the input variables and O_i the output variables, and likewise for P_j. P_i and P_j are independent if they satisfy

$$I_j \cap O_i = \varnothing,$$
$$I_i \cap O_j = \varnothing,$$
$$O_i \cap O_j = \varnothing.$$

Violation of the first condition introduces a flow dependency, corresponding to the first segment producing a result used by the second segment. The second condition represents an anti-dependency, when the second segment produces a variable needed by the first segment. The third and final condition represents an output dependency: when two segments write to the same location, the result comes from the logically last executed segment.

Consider the following functions, which demonstrate several kinds of dependencies:

```
1: function Dep(a, b)
2: c := a * b
3: d := 3 * c
4: end function
```

In this example, instruction 3 cannot be executed before (or even in parallel with) instruction 2, because instruction 3 uses a result from instruction 2. It violates condition 1, and thus introduces a flow dependency.

```
1: function NoDep(a, b)
2: c := a * b
3: d := 3 * b
4: e := a + b
5: end function
```

In this example, there are no dependencies between the instructions, so they can all be run in parallel.

Bernstein's conditions do not allow memory to be shared between different processes. For that, some means of enforcing an ordering between accesses is necessary, such as semaphores, barriers or some other synchronization method.

Subtasks in parallel programming

There are many different kinds of parallel computers. They are distinguished by the kind of interconnection between processors (known as "processing elements" or PEs) and memory. Flynn's taxonomy, a classification of parallel computers according to data and instruction streams, is commonly used.

Types of parallelism

Bit-level parallelism

From the advent of very-large-scale integration (VLSI) computer-chip fabrication technology in the 1970s until about 1986, speed-up in computer architecture was driven by doubling computer word size—the amount of information the processor can manipulate per cycle. Increasing the word size reduces the number of instructions the processor must execute to perform an operation on variables whose sizes are greater than the length of the word. For example, where an 8-bit processor must add two 16-bit integers, the processor must first add the 8 lower-order bits from each integer, then add the 8 higher-order bits, requiring two instructions to complete a single operation. A 16-bit processor would be able to complete the operation with a single instruction.

Historically, 4-bit microprocessors were replaced with 8-bit, then 16-bit, then 32-bit microprocessors. This trend generally came to an end with the introduction of 32-bit processors, which has been a standard in general-purpose computing for two decades. Not until recently (c. 2003–2004) with the advent of x86-64 architectures did 64-bit processors become commonplace.

Instruction-level parallelism

A computer program is, in essence, a stream of instructions executed by a processor. These instructions can be reordered and combined into groups which are then executed in parallel without changing the result of the program. This is known as instruction-level parallelism. Advances in instruction-level parallelism dominated computer architecture from the mid-1980s until the mid-1990s.

Modern processors have multi-stage instruction pipelines. Each stage in the pipeline corresponds to a different action the processor performs on that instruction in that stage; a processor with an N-stage pipeline can have up to N different instructions at different stages of completion. The canonical example of a pipelined processor is a RISC processor, with five stages: instruction fetch, decode, execute, memory access, and write back. The Pentium 4 processor had a 35-stage pipeline.

In addition to instruction-level parallelism from pipelining, some processors can issue more than one instruction at a time. These are known as superscalar processors. Instructions can be grouped together only if there is no data dependency between them. Scoreboarding and the Tomasulo algorithm (which is similar to scoreboarding but makes use of register renaming) are two of the most common techniques for implementing out-of-order execution and instruction-level parallelism.

Data parallelism

Data parallelism is parallelism inherent in program loops, which focuses on distributing the data across different computing nodes to be processed in parallel. "Parallelizing loops often leads to similar (not necessarily identical) operation sequences or functions being performed on elements of a large data structure." Many scientific and engineering applications exhibit data parallelism.

A loop-carried dependency is the dependence of a loop iteration on the output of one or more previous iterations. Loop-carried dependencies prevent the parallelization of loops. For example, consider the following pseudocode that computes the first few Fibonacci numbers:

```
1: PREV1 := 0
2: PREV2 := 1
3: CUR := 1
4: do:
5: CUR := PREV1 + PREV2
6: PREV1 := PREV2
7: PREV2 := CUR
8: while (CUR < 10)
```

This loop cannot be parallelized because CUR depends on itself (PREV2) and PREV1, which are computed in each loop iteration. Since each iteration depends on the result of the previous one, they cannot be performed in parallel. As the size of a problem gets bigger, the amount of data-parallelism available usually does as well.

Task parallelism

Task parallelism is the characteristic of a parallel program that entirely different calculations can be performed on either the same or different sets of data. This contrasts with data parallelism, where the same calculation is performed on the same or different sets of data. Task parallelism does not usually scale with the size of a problem.

Hardware

Memory and communication

Main memory in a parallel computer is either shared memory (shared between all processing elements in a single address space), or distributed memory (in which each processing element has its own local address space). Distributed memory refers to the fact that the memory is logically distributed, but often implies that it is physically distributed as well. Distributed shared memory and memory virtualization combine the two approaches, where the processing element has its own local memory and access to the memory on non-local processors. Accesses to local memory are typically faster than accesses to non-local memory. On the supercomputer Blue Gene/L, the memory architecture is local, but it sometimes appears to the programmer as shared memory.

Computer architectures in which each element of main memory can be accessed with equal latency and bandwidth are known as uniform memory access (UMA) systems. Typically, that can be achieved only by a shared memory system, in which the memory is not physically distributed. A system that does not have this property is known as a non-uniform memory access (NUMA) architecture. Distributed memory systems have non-uniform memory access.

Computer systems make use of caches—small and fast memories located close to the processor which store temporary copies of memory values (nearby in both the physical and logical sense). Parallel computer systems have difficulties with caches that may store the same value in more than one location, with the possibility of incorrect program execution. These computers require a cache coherency system, which keeps track of cached values and strategically purges them, thus ensuring correct program execution. Bus snooping is one of the most common methods for keeping track of which values are being accessed (and thus should be purged). Designing large, high-performance cache coherency systems is a very difficult problem in computer architecture. As a result, shared memory computer architectures do not scale as well as distributed memory systems do.

Processor–processor and processor–memory communication can be implemented in hardware in several ways, including via shared (either multiported or multiplexed) memory, a crossbar switch, a shared bus or an interconnect network of a myriad of topologies including star, ring, tree, hypercube, fat hypercube (a hypercube with more than one processor at a node), or n-dimensional mesh.

Parallel computers based on interconnect networks need to have some kind of routing to enable the passing of messages between nodes that are not directly connected. The medium used for communication between the processors is likely to be hierarchical in large multiprocessor machines.

Classes of parallel computers

Parallel computers can be roughly classified according to the level at which the hardware supports parallelism. This classification is broadly analogous to the distance between basic computing nodes. These are not mutually exclusive; for example, clusters of symmetric multiprocessors are relatively common.

Multi-core computing

A multi-core processor is a processor that includes multiple execution units ("cores") on the same chip. These processors differ from superscalar processors, which can issue multiple instructions per cycle from one instruction stream (thread); in contrast, a multi-core processor can issue multiple instructions per cycle from multiple instruction streams. IBM's Cell microprocessor, designed for use in the Sony PlayStation 3, is a prominent multi-core processor. Each core in a multi-core processor can potentially be superscalar as well—that is, on every cycle, each core can issue multiple instructions from one instruction stream.

Simultaneous multithreading (of which Intel's Hyper-Threading is the best known) was an early form of pseudo-multi-coreism. A processor capable of simultaneous multithreading has only one execution unit ("core"), but when that execution unit is idling (such as during a cache miss), it uses that execution unit to process a second thread. IBM's Cell microprocessor, designed for use in the Sony PlayStation 3, is another prominent multi-core processor.

Symmetric multiprocessing

A symmetric multiprocessor (SMP) is a computer system with multiple identical processors that share memory and connect via a bus. Bus contention prevents bus architectures from scaling. As a result, SMPs generally do not comprise more than 32 processors. "Because of the small size of the processors and the significant reduction in the requirements for bus bandwidth achieved by large caches, such symmetric multiprocessors are extremely cost-effective, provided that a sufficient amount of memory bandwidth exists."

Distributed computing

A distributed computer (also known as a distributed memory multiprocessor) is a distributed memory computer system in which the processing elements are connected by a network. Distributed computers are highly scalable.

Cluster computing

A cluster is a group of loosely coupled computers that work closely together, so that in some respects they can be regarded as a single computer. Clusters are composed of multiple standalone machines connected by a network. While machines in a cluster do not have to be symmetric, load balancing is more difficult if they are not. The most common type of cluster is the Beowulf cluster, which is a cluster implemented on multiple identical commercial off-the-shelf computers connected with a TCP/IP Ethernet local area network. Beowulf technology was originally developed by Thomas Sterling and Donald Becker. The vast majority of the TOP500 supercomputers are clusters.

Massively parallel computing

A massively parallel processor (MPP) is a single computer with many networked processors. MPPs have many of the same characteristics as clusters, but MPPs have specialized interconnect networks (whereas clusters use commodity hardware for networking). MPPs also tend to be larger than clusters, typically having "far more" than 100 processors. In an MPP, "each CPU contains its own memory and copy of the operating system and application. Each subsystem communicates with the others via a high-speed interconnect."

Grid computing

Grid computing is the most distributed form of parallel computing. It makes use of computers communicating over the Internet to work on a given problem. Because of the low bandwidth and extremely high latency available on the Internet, grid computing typically deals only with embarrassingly parallel problems. Most grid computing applications use spare computing cycles, doing useful work for scientific projects, such as protein folding, during periods of low workload. Volunteer computing projects such as BOINC have the largest numbers of grid computing users. Grid computing is used in financial risk and scientific research.

Specialized parallel computers

Within parallel computing, there are specialized parallel devices that remain niche areas of interest. While not domain-specific, they tend to be applicable to only a few classes of parallel problems.

Reconfigurable computing with field-programmable gate arrays

Reconfigurable computing is the use of a field-programmable gate array (FPGA) as a co-processor to a general-purpose computer. An FPGA is, in essence, a computer chip that can rewire itself for a given task.

FPGAs can be programmed with hardware description languages such as VHDL or Verilog. However, programming in these languages can be tedious. Several vendors have created C to HDL languages that attempt to emulate the syntax and semantics of the C programming language, with which most programmers are familiar. The best known C to HDL languages are Mitrion-C, Impulse C, DIME-C, and Handel-C. Specific subsets of SystemC based on C++ can also be used for this purpose.

AMD's decision to open its HyperTransport technology to third-party vendors has become the enabling technology for high-performance reconfigurable computing. According to Michael R. D'Amour, Chief Operating Officer of DRC Computer Corporation, "when we first walked into AMD, they called us crazy."

General-purpose computing on graphics processing units (GPGPU)

General-purpose computing on graphics processing units is a fairly recent trend in computer engineering research. GPUs are co-processors that have been heavily optimized for computer graphics processing. Computer graphics processing is a field dominated by data parallel operations—particularly linear algebra matrix operations.

In the early days, GPGPU programs used the normal graphics APIs for executing programs. However, several new programming languages and platforms have been built to do general purpose computation on GPUs, with both Nvidia and AMD releasing programming environments with CUDA and Close to Metal respectively. Other GPU programming languages include BrookGPU, PeakStream, and RapidMind. Nvidia has also released specific products for computation in their Tesla series. The technology consortium Khronos Group has released the OpenCL specification, which is a framework for writing programs that execute across platforms consisting of CPUs and GPUs. AMD, Apple, Intel, Nvidia and others are supporting OpenCL.

Application-specific integrated circuits

Several application-specific integrated circuit (ASIC) approaches have been devised for dealing with parallel applications.

Because an ASIC is (by definition) specific to a given application, it can be fully optimized for that application. As a result, for a given application, an ASIC tends to outperform a general-purpose computer. However, ASICs are created by UV photolithography. This process requires a mask set, which can be extremely expensive. A mask set can cost over a million US dollars. (The smaller the transistors required for the chip, the more expensive the mask will be.) Meanwhile, performance increases in general-purpose computing over time (as described by Moore's law) tend to wipe out these gains in only one or two chip generations. High initial cost, and the tendency to be overtaken by Moore's-law-driven general-purpose computing has rendered ASICs unfeasible for most parallel computing applications. However, some have been built. One example is the peta-flop RIKEN MDGRAPE-3 machine which uses custom ASICs for molecular dynamics simulation.

Vector processors

A vector processor is a CPU or computer system that can execute the same instruction on large sets of data. "Vector processors have high-level operations that work on linear arrays of numbers or vectors. An example vector operation is A = B × C, where A, B, and C are each 64-element vectors of 64-bit floating-point numbers." They are closely related to Flynn's SIMD classification.

Cray computers became famous for their vector-processing computers in the 1970s and 1980s. However, vector processors—both as CPUs and as full computer systems—have generally disappeared. Modern processor instruction sets do include some vector processing instructions, such as with Freescale Semiconductor's AltiVec and Intel's Streaming SIMD Extensions (SSE).

Software

Parallel programming languages

Concurrent programming languages, libraries, APIs, and parallel programming models have been created for programming parallel computers. These can generally be divided into classes based on the assumptions they make about the underlying memory architecture—shared memory, distributed memory, or shared distributed memory. Shared memory programming languages communicate by manipulating shared memory variables. Distributed memory uses message passing. POSIX Threads and OpenMP are two of the most widely used shared memory APIs, whereas Message Passing Interface (MPI) is the most widely used message-passing system API. One concept used in programming parallel programs is the future concept, where one part of a program promises to deliver a required datum to another part of a program at some future time.

Efforts to standardize parallel programming include an open standard called OpenHMPP for hybrid multi-core parallel programming. The OpenMP application programming interface supports multi-platform shared memory multiprocessing programming in C, C++ and Fortran on many architectures, including Unix and Microsoft Windows platforms. It consists of a set of compiler directives, library routines, and environment variables that influence run-time behavior.

Message Passing Interface (MPI) is a widely used standard for message passing that can be used in a variety of contexts. It is used in the Beowulf cluster. See also Parallel Virtual Machine (PVM).

Unified Parallel C (UPC) is a parallel extension to the C programming language following the partitioned global address space (PGAS) paradigm. UPC is relatively easy to learn for anyone familiar with C and has both commercial and open source compilers.

Automatic parallelization

Automatic parallelization of a sequential program by a compiler is the holy grail of parallel computing. Despite decades of work by compiler researchers, automatic parallelization has had only limited success.

Mainstream parallel programming languages remain either explicitly parallel or (at best) partially implicit, in which a programmer gives the compiler directives for parallelization. A few fully implicit parallel programming languages exist—SISAL, Parallel Haskell, and (for FPGAs) Mitrion-C—but these have not seen widespread use. As a computer system grows more complex, the mean time between failures usually decreases. Application checkpointing is a technique whereby the computer system takes a "snapshot" of the application—a record of all current resource allocations and variable states, akin to a core dump—; this information can be used to restore the program if the computer should fail. Application checkpointing means that the program has to restart from only its last checkpoint rather than the beginning. While checkpointing provides benefits in a variety of situations, it is especially useful in highly parallel systems with a large number of processors used in high performance computing.

Algorithmic methods

As parallel computers become larger and faster, we are now able to solve problems that had previously taken too long to run. Fields as varied as bioinformatics (protein folding and sequence analysis) and economics (mathematical finance) have taken advantage of parallel computing. Common types of problems found in parallel computing applications are:

- dense linear algebra
- sparse linear algebra
- spectral methods (such as Cooley–Tukey fast Fourier transform)
- N-body problems (such as Barnes–Hut simulation)
- structured grid problems (such as Lattice Boltzmann methods)
- unstructured grid problems (such as finite element analysis)
- Monte Carlo simulation
- combinational logic (such as brute-force cryptographic techniques)
- graph traversal (such as sorting algorithms)
- dynamic programming
- branch and bound methods
- graphical models (such as detecting hidden Markov models and constructing Bayesian networks)
- finite state machine simulation

Fault-tolerance

Parallel computing can also be applied to the design of fault-tolerant computer systems, particularly via lockstep systems performing the same operation in parallel. This provides redundancy in case one component should fail, and also allows automatic error detection and error correction if the results differ. These methods can be used to help prevent single-event upsets caused by transient errors. Although additional measures may be required in embedded or specialized systems, this method can provide a cost effective approach to achieve n-modular redundancy in commercial off-the-shelf systems.

History

The origins of true (MIMD) parallelism go back to Luigi Federico Menabrea and his Sketch of the Analytic Engine Invented by Charles Babbage.

In April 1958, S. Gill (Ferranti) discussed parallel programming and the need for branching and waiting. Also in 1958, IBM researchers John Cocke and Daniel Slotnick discussed the use of parallelism in numerical calculations for the first time. Burroughs Corporation introduced the D825 in 1962, a four-processor computer that accessed up to 16 memory modules through a crossbar switch. In 1967, Amdahl and Slotnick published a debate about the feasibility of parallel processing at American Federation of Information Processing Societies Conference. It was during this debate that Amdahl's law was coined to define the limit of speed-up due to parallelism.

In 1969, Honeywell introduced its first Multics system, a symmetric multiprocessor system capable of running up to eight processors in parallel. C.mmp, a multi-processor project at Carnegie Mellon University in the 1970s, was among the first multiprocessors with more than a few processors. The first bus-connected multiprocessor with snooping caches was the Synapse N+1 in 1984.

SIMD parallel computers can be traced back to the 1970s. The motivation behind early SIMD computers was to amortize the gate delay of the processor's control unit over multiple instructions. In 1964, Slotnick had proposed building a massively parallel computer for the Lawrence Livermore National Laboratory. His design was funded by the US Air Force, which was the earliest SIMD parallel-computing effort, ILLIAC IV. The key to its design was a fairly high parallelism, with up to 256 processors, which allowed the machine to work on large datasets in what would later be known as vector processing. However, ILLIAC IV was called "the most infamous of supercomputers", because the project was only one fourth completed, but took 11 years and cost almost four times the original estimate. When it was finally ready to run its first real application in 1976, it was outperformed by existing commercial supercomputers such as the Cray-1.

Biological brain as massively parallel computer

In the early 1970s, at the MIT Computer Science and Artificial Intelligence Laboratory, Marvin Minsky and Seymour Papert started developing the Society of Mind theory, which views the biological brain as massively parallel computer. In 1986, Minsky published The Society of Mind, which claims that "mind is formed from many little agents, each mindless by itself". The theory attempts to explain how what we call intelligence could be a result of the interaction of non-intelligent parts. Minsky says that the biggest source of ideas about the theory came from his work in trying to create a machine that uses a robotic arm, a video camera, and a computer to build with children's blocks.

Opposition to parallel computing

Applying parallel computers to some problems has sometimes been met with skepticism. Among the reasons for skepticism is that some problems are believed to be inherently serial, and that parallelization of certain common algorithms will be limited by Amdahl's law. Another reason is that the programming of parallel computers is difficult, and that parallel computers are expected to have a smaller market than conventional computers. Yet another reason is that conventional computers have been growing at a rate consistent with Moore's law, and may eventually overtake the performance of parallel computers that do not benefit from Moore's law. Gustafson's law was formulated in response to these criticisms.

Parallel computing in microprocessors

In 2005, Intel, AMD, and other processor makers began to release multi-core microprocessors. Since around 2000, the typical power consumption of new microprocessors has increased dramatically. Intel and AMD have begun to produce microprocessors that have more than one core (processing unit), with each core being equivalent to a single-core microprocessor. Multi-core microprocessors were introduced because they allow higher performance without increasing the power consumption. Sometimes they can even consume less power overall, because the power management circuitry can put whole cores to sleep.

In 2006, Intel released a family of dual-core microprocessors, the Core 2 family, and AMD released the Athlon 64 X2 family. Intel's Core 2 Extreme QX6700 and Core 2 Quad Q6600 are quad-core microprocessors. Each core has a throughput of 2 to 4 instructions per cycle, and can execute up to 8 instructions simultaneously.

In 2008, Intel released the Core i7 quad-core microprocessor, which can execute up to 16 instructions simultaneously. According to David Patterson, "Intel assumed programmers would rise to the challenge of parallelism, but the vast majority of programmers today don't grasp concurrency, let alone parallelism."

In 2009, Intel released the Core i5 quad-core microprocessor, which can execute up to 16 instructions simultaneously. Intel has released a prototype chip with 48 cores, the Single-chip Cloud Computer.

Timeline of parallel computing

- 1962 – Burroughs Corporation introduces the D825, a four-processor computer that accesses up to 16 memory modules through a crossbar switch.
- 1967 – Amdahl and Slotnick publish a debate about the feasibility of parallel processing at American Federation of Information Processing Societies Conference. It is during this debate that Amdahl's law is coined to define the limit of speed-up due to parallelism.
- 1969 – Honeywell introduces its first Multics system, a symmetric multiprocessor system capable of running up to eight processors in parallel.
- 1970s – Cray computers become famous for their vector-processing computers.
- 1970 – C.mmp, a multi-processor project at Carnegie Mellon University in the 1970s, is among the first multiprocessors with more than a few processors.
- 1971 – Slotnick publishes the initial design for ILLIAC IV, the earliest SIMD parallel-computing effort.
- 1976 – ILLIAC IV is finally ready to run its first real application, but is outperformed by existing commercial supercomputers such as the Cray-1.
- 1984 – The first bus-connected multiprocessor with snooping caches is the Synapse N+1.
- 1986 – Minsky publishes The Society of Mind, which claims that "mind is formed from many little agents, each mindless by itself".
- 2005 – Intel, AMD, and other processor makers begin to release multi-core microprocessors.
- 2006 – Intel releases a family of dual-core microprocessors, the Core 2 family, and AMD releases the Athlon 64 X2 family.
- 2008 – Intel releases the Core i7 quad-core microprocessor, which can execute up to 16 instructions simultaneously.
- 2009 – Intel releases the Core i5 quad-core microprocessor, which can execute up to 16 instructions simultaneously. Intel has released a prototype chip with 48 cores, the Single-chip Cloud Computer.

Let us now discuss various types of distributed computing.

11.2.1 Parallel computing

Traditionally, a software has been written for serial computation. i.e., it is to be run on a single computer having a single processor. Here a problem is broken into a series of instructions. Instructions are to be executed one by one sequentially. Only one instruction is executed at a time. It is referred to as serial computing. Fig.11.2 shows serial processing.

Fig. 11.2: Serial processing

Suppose there are five men lifting a rock with a single rope. Here all of them are trying to lift the rope in parallel. Similarly in parallel computing a problem is solved by different processing units. The problem will be subdivided among the various CPUs. Parallel computing is a form of computation in which many calculations are carried out simultaneously, operating on the principle that large problems can often be divided into smaller ones, which are then solved concurrently (in parallel). There are several different forms of parallel computing: bit-level, instruction level, data, and task parallelism. Parallelism has been employed for many years, mainly in high-performance computing, but interest in it has grown lately due to the physical constraints preventing frequency scaling. As power consumption (and consequently heat generation) by computers has become a concern in recent years, parallel computing has become the dominant paradigm in computer architecture, mainly in the form of multi-core processors.

Fig.11.3: Parallel processing

In computer science, parallel computing is the simultaneous execution of some combination of multiple instances of programs, using more than one processor. Parallel computing is closely related to concurrent computing—they are frequently used together, and often conflated, though the two are distinct: it is possible to have parallelism without concurrency (such as bit-level parallelism), and concurrency without parallelism (such as multitasking by time-sharing on a single-core CPU). In parallel computing, a computational task is typically broken down in several, often many, very similar subtasks that can be processed independently and whose results are combined afterwards, upon completion. In contrast, in concurrent computing, the various processes often do not address related tasks; when they do, as is typical in distributed computing, the separate tasks may have a varied nature and often require some inter-process communication during execution.

Parallel computers can be roughly classified according to the level at which the hardware supports parallelism, with multi-core and multi-processor computers having multiple processing elements within a single machine, while clusters, MPPs, and grids use multiple computers to work on the same task. Specialized parallel computer architectures are sometimes used alongside traditional processors, for accelerating specific tasks.

Parallel computer programs are more difficult to write than sequential ones, because concurrency introduces several new classes of potential software bugs, of which race conditions are the most common. Communication and synchronization between the different subtasks are typically some of the greatest obstacles to getting good parallel program performance. The maximum possible speed-up of a single program as a result of parallelization is known as Amdahl's law.

Background

Traditionally, computer software has been written for serial computation. To solve a problem, an algorithm is constructed and implemented as a serial stream of instructions. These instructions are executed on a central processing unit on one computer. Only one instruction may execute at a time—after that instruction is finished, the next is executed.

Parallel computing, on the other hand, uses multiple processing elements simultaneously to solve a problem. This is accomplished by breaking the problem into independent parts so that each processing element can execute its part of the algorithm simultaneously with the others. The processing elements can be diverse and include resources such as a single computer with multiple processors, several networked computers, specialized hardware, or any combination of the above.

Frequency scaling was the dominant reason for improvements in computer performance from the mid-1980s until 2004. The runtime of a program is equal to the number of instructions multiplied by the average time per instruction. Maintaining everything else constant, increasing the clock frequency decreases the average time it takes to execute an instruction. An increase in frequency thus decreases runtime for all compute-bound programs. However, power consumption by a chip is given by the equation $P = C \times V^2 \times F$, where P is power, C is the capacitance being switched per clock cycle (proportional to the number of transistors whose inputs change), V is voltage, and F is the processor frequency (cycles per second). Increases in frequency increase the amount of power used in a processor. Increasing processor power consumption led ultimately to Intel's May 2004 cancellation of its Tejas and Jayhawk processors, which is commonly cited as the end of frequency scaling as the dominant computer architecture paradigm.

Moore's Law is the empirical observation that the number of transistors in a microprocessor doubles every 18 to 24 months. Despite power consumption issues, and repeated predictions of its end, Moore's law is still in effect. With the end of frequency scaling, these additional transistors (which are no longer used for frequency scaling) can be used to add extra hardware for parallel computing.

Amdahl's law and Gustafson's law

Optimally, the speed-up from parallelization would be linear—doubling the number of processing elements should halve the runtime, and doubling it a second time should again halve the runtime. However, very few parallel algorithms achieve optimal speed-up. Most of them have a near-linear speed-up for small numbers of processing elements, which flattens out into a constant value for large numbers of processing elements.

The potential speed-up of an algorithm on a parallel computing platform is given by Amdahl's law, originally formulated by Gene Amdahl in the 1960s. It states that a small portion of the program which cannot be parallelized will limit the overall speed-up available from parallelization. A program solving a large mathematical or engineering problem will typically consist of several parallelizable parts and several non-parallelizable (serial) parts. If the non-parallelizable part of a program accounts for 10% of the runtime ($P = 0.9$), we can get no more than a 10 times speed-up, regardless of how many processors are added. This puts an upper limit on the usefulness of adding more parallel execution units. "When a task cannot be partitioned because of sequential constraints, the application of more effort has no effect on the schedule. The bearing of a child takes nine months, no matter how many women are assigned."

Amdahl's law only applies to cases where the problem size is fixed. In practice, as more computing resources become available, they tend to get used on larger problems (larger datasets), and the time spent in the parallelizable part often grows much faster than the inherently serial work. In this case, Gustafson's law gives a less pessimistic and more realistic assessment of parallel performance.

Dependencies

Understanding data dependencies is fundamental in implementing parallel algorithms. No program can run more quickly than the longest chain of dependent calculations (known as the critical path), since calculations that depend upon prior calculations in the chain must be executed in order. However, most algorithms do not consist of just a long chain of dependent calculations; there are usually opportunities to execute independent calculations in parallel.

Let P_i and P_j be two program segments. Bernstein's conditions describe when the two are independent and can be executed in parallel. For P_i, let I_i be all of the input variables and O_i the output variables, and likewise for P_j. P_i and P_j are independent if they satisfy

$$I_j \cap O_i = \varnothing,$$
$$I_i \cap O_j = \varnothing,$$
$$O_i \cap O_j = \varnothing.$$

Violation of the first condition introduces a flow dependency, corresponding to the first segment producing a result used by the second segment. The second condition represents an anti-dependency, when the second segment produces a variable needed by the first segment. The third and final condition represents an output dependency: when two segments write to the same location, the result comes from the logically last executed segment.

Consider the following functions, which demonstrate several kinds of dependencies:

```
1: function Dep(a, b)
2: c := a * b
3: d := 3 * c
4: end function
```

In this example, instruction 3 cannot be executed before (or even in parallel with) instruction 2, because instruction 3 uses a result from instruction 2. It violates condition 1, and thus introduces a flow dependency.

```
1: function NoDep(a, b)
2: c := a * b
3: d := 3 * b
4: e := a + b
5: end function
```

In this example, there are no dependencies between the instructions, so they can all be run in parallel.

Bernstein's conditions do not allow memory to be shared between different processes. For that, some means of enforcing an ordering between accesses is necessary, such as semaphores, barriers or some other synchronization method.

Subtasks in parallel programming

There are many different kinds of parallel computers. They are distinguished by the kind of interconnection between processors (known as "processing elements" or PEs) and memory. Flynn's taxonomy, a classification of parallel computers according to data and instruction streams, is commonly used.

Types of parallelism

Bit-level parallelism

From the advent of very-large-scale integration (VLSI) computer-chip fabrication technology in the 1970s until about 1986, speed-up in computer architecture was driven by doubling computer word size—the amount of information the processor can manipulate per cycle. Increasing the word size reduces the number of instructions the processor must execute to perform an operation on variables whose sizes are greater than the length of the word. For example, where an 8-bit processor must add two 16-bit integers, the processor must first add the 8 lower-order bits from each integer, then add the 8 higher-order bits, requiring two instructions to complete a single operation. A 16-bit processor would be able to complete the operation with a single instruction.

Historically, 4-bit microprocessors were replaced with 8-bit, then 16-bit, then 32-bit microprocessors. This trend generally came to an end with the introduction of 32-bit processors, which has been a standard in general-purpose computing for two decades. Not until recently (c. 2003–2004) with the advent of x86-64 architectures did 64-bit processors become commonplace.

Instruction-level parallelism

A computer program is, in essence, a stream of instructions executed by a processor. These instructions can be reordered and combined into groups which are then executed in parallel without changing the result of the program. This is known as instruction-level parallelism. Advances in instruction-level parallelism dominated computer architecture from the mid-1980s until the mid-1990s.

Modern processors have multi-stage instruction pipelines. Each stage in the pipeline corresponds to a different action the processor performs on that instruction in that stage; a processor with an N-stage pipeline can have up to N different instructions at different stages of completion. The canonical example of a pipelined processor is a RISC processor, with five stages: instruction fetch, decode, execute, memory access, and write back. The Pentium 4 processor had a 35-stage pipeline.

In addition to instruction-level parallelism from pipelining, some processors can issue more than one instruction at a time. These are known as superscalar processors. Instructions can be grouped together only if there is no data dependency between them. Scoreboarding and the Tomasulo algorithm (which is similar to scoreboarding but makes use of register renaming) are two of the most common techniques for implementing out-of-order execution and instruction-level parallelism.

Data parallelism

Data parallelism is parallelism inherent in program loops, which focuses on distributing the data across different computing nodes to be processed in parallel. "Parallelizing loops often leads to similar (not necessarily identical) operation sequences or functions being performed on elements of a large data structure." Many scientific and engineering applications exhibit data parallelism.

A loop-carried dependency is the dependence of a loop iteration on the output of one or more previous iterations. Loop-carried dependencies prevent the parallelization of loops. For example, consider the following pseudocode that computes the first few Fibonacci numbers:

```
1: PREV1 := 0
2: PREV2 := 1
3: CUR := 1
4: do:
5: CUR := PREV1 + PREV2
6: PREV1 := PREV2
7: PREV2 := CUR
8: while (CUR < 10)
```

This loop cannot be parallelized because CUR depends on itself (PREV2) and PREV1, which are computed in each loop iteration. Since each iteration depends on the result of the previous one, they cannot be performed in parallel. As the size of a problem gets bigger, the amount of data-parallelism available usually does as well.

Task parallelism

Task parallelism is the characteristic of a parallel program that entirely different calculations can be performed on either the same or different sets of data. This contrasts with data parallelism, where the same calculation is performed on the same or different sets of data. Task parallelism does not usually scale with the size of

Serial computing	Parallel computing
A single processor is used.	Multiple processors are used with a shared memory.
A problem is broken into a discrete series of instructions.	A problem is broken into discrete parts that can be solved concurrently.
Instructions are executed sequentially one after another.	Instructions from each part execute simultaneously on different processors.
Only one instruction is executed on a single processor at any moment of time.	More than one instruction is executed on multiple processors at any moment of time.

Table 11.1: Comparison between serial and parallel processing

A supercomputer is simply a fast computer with a large number of CPUs. An ordinary computer uses serial processing. But the super computer works in an entirely different way, typically using parallel processing instead of the serial processing. i.e., instead of doing one thing at a time, it does many things at a time. AADITYA super computer used by Indian Institute of Tropical Meteorology is currently considered as India's fastest supercomputer. AADITYA is 790 + Tera Flops High Performance Computing System formed using IBM iDataPlex cluster.

a. Advantages of parallel computing

Parallel computing provides several advantages. Some of them are given below:

- In parallel computing environment even when one or more nodes fails, the whole system still work with reduced performance. It is called fault tolerance.
- Each user can share the computing power and storage resources in the system with other users.
- Distributing several tasks to different nodes can help sharing of load to the whole system. It is called load sharing.
- It is easily expandable. It can scale to large extend.

b. Disadvantages of parallel computing

Some of the limitations of parallel computing are:

- Parallel applications are much more complex than corresponding serial applications.
- A program may run on one machine, but when ported to a different computer, significant changes must be made in order to allow the program to run properly.

11.2.2 Grid computing

Imagine that several million computers (servers, desktops, laptops, etc.) and instruments like, mobile phones, telescopes, sensors, etc. owned by thousands of different people are connected together to form a single huge powerful computer. This is grid computing. Grid computing is described as a world in which computational power (resources, services, data) is readily available like electric power. Here users get access to computational power just like electricity through wall sockets with no care or consideration for where or how the electricity is actually generated. Computers on a grid have a program on them, that allows unused resources (usually processing time and memory) to be used by another computer on the grid.

The speed of the connections between the computers on the grid are relatively slow, therefore processing tasks are broken up into independent parts and sent out to different computers on the grid. When a computer completes its part, it sends the results back to the server. Services over grids can be of many types - as Knowledge grid, Data grid, Computational grid, etc. The grids are capable to solve larger, more complex problems in a short time. They are easier to collaborate with and these make better use of existing hardware. Grid computing is used in disaster management, weather forecasting, market forecasting, bio-informatics, etc. A grid computing environment is represented in Figure 11.5.

Fig. 11.5: Grid computing environment

a. Advantages of grid computing

The benefits of using grid computing are:

- Grids are capable to solve larger, more complex problems in a short time.
- Grid computing makes better use of existing hardware.
- Scalable - easy to increase computing power by adding desktops or servers.

b. Disadvantages of grid computing

The drawbacks of grid computing are:

- The interconnection between computers is slower and therefore affects processing speed.
- Licensing issues across different servers/computers may affect working of certain applications.

11.2.3 Cluster computing

Fig. JJ.6: A computing cluster

Cluster computing is a form of computing in which a group of personal computers, storage devices, etc. are linked together so that they can work like a single computer. The components of a cluster are connected to each other through fast local area networks. Clusters provide computational power through parallel processing. It is a relatively low cost form of a parallel processing machine used for scientific and other applications. Another reason for using clusters is to provide fault tolerance, that is, to ensure that computational power is always available. Figure 11.6 displays a computing cluster.

Clusters have evolved to support applications varying from e-Commerce to high performance database applications. Linux is the most widely used operating system for cluster computers.

a. Advantages of cluster computing

The advantages of using cluster computing are:

Price performance ratio: Cluster computing significantly reduces the cost of processing power.

Availability: If any one of the system components fails, the system as a whole stays highly available.

Scalability: Processors and nodes can be added to a cluster whenever demand Increases

b. Disadvantages of cluster computing

The disadvantages of using cluster computing are:

Programmability issues: If there are differences in the software used in the different computers, there may be issues while combining all of them as a single entity.

Problem in finding fault: Since we deal with a single entity, we may have to face the difficulty in identifying the problematic component.

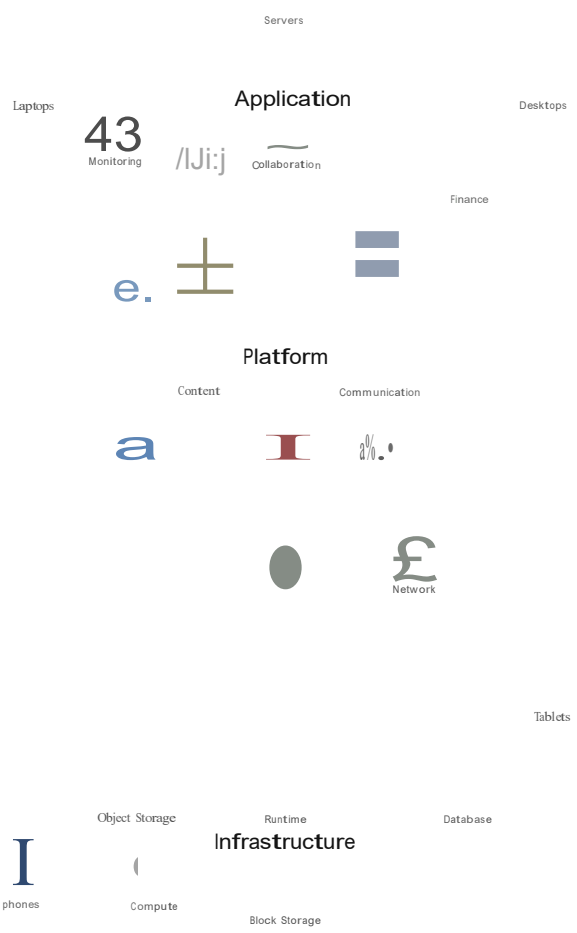
Beowulf Clusters are cheap clusters created using personal computers. We can create a Beowulf cluster with a few old computers and a LAN connection. Computers in Beowulf clusters are normally run using free and open source operating systems like Linux, Solaris,etc. They do not give top level performance, but their performance is many times better than a single computer.

11.2.4 Cloud computing

Cloud computing is an emerging computing technology that uses the Internet and central remote servers to maintain data and applications. It refers to the use of computing resources that reside on a remote machine and are delivered to the end user as a service over a network.

e-mail service is an example of cloud computing. Our web based e-mail service providers like Yahoo!, Gmail, Outlook, etc. takes care of storing all the hardware and software necessary to support our personal e-mail account. When we need to access our e-mail we open our web browser, go to the e-mail client, and log in. The most important part of this process is having an Internet access. Our e-mail messages and the software that manages e-mail are not stored in our computer. The e-mail service providers store them in the cloud. We access it from the cloud through an Internet connection anywhere, anytime.

Similar to e-mail service, office software (word processors, spreadsheets, etc.), graphic software, etc. are now available over cloud. People can use these software for their benefit and can even store the files (documents, spreadsheets, images, etc.) created in their private storage space in the cloud. Cloud computing is a computing model, where resources such as computing power, storage, network and



software are combined and provided as services on the Internet in a remotely accessible fashion.

Fig. 11.7: Cloud computing

In 1961, 10 years after coining the term artificial intelligence, Professor John McCarthy conceptualised sharing computer hardware resources and applications. He envisioned that computing power can be supplied like gas or water for free or a minimal cost. One of the first milestones in cloud computing history was the arrival of Salesforce.com in 1999, which pioneered the concept of delivering enterprise applications through a simple website. It paved the way for both specialist and mainstream software firms to deliver applications over the Internet. Now cloud computing is emerging as one of the hottest topic in field of information technology.

John McCarthy (1927-2011)

Cloud computing is so named because the information being accessed is found in the 'clouds' or a remote place just like clouds in the sky. To use the cloud computing environment, Internet access and an account with a cloud service provider is required. Cloud computing is a subscription-based service where we can obtain networked storage space and computer resources. Figure **11.**7 displays a diagrammatic representation of cloud computing.

a. Cloud service models

Cloud providers offer services that can be grouped into three major services. They are Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (laaS). Let us discuss them in detail.

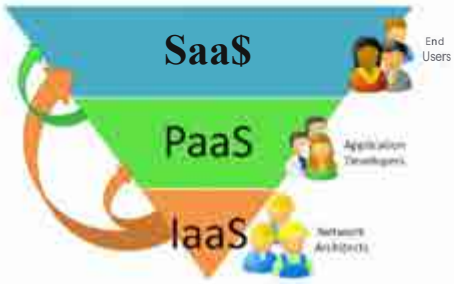


Fig. 11.8: Basic cloud computing models

1. Software as a Service

A SaaS provider gives subscribers access to both resources and applications. Here a complete application is offered to the customer, as a service on demand. Consumers purchase the ability to access and use an application or service that is hosted in the cloud.

Suppose we are using Google Docs which is available for free, for all Gmail account holders. Here a single instance of the service runs on the cloud and multiple end users are serviced. SaaS makes it unnecessary for us to have a copy of software to be installed on our devices like desktop, laptop, mobile, etc. In the case of Google Docs, only one copy of word processor runs on the cloud. Users can access this copy and need not have the software installed on their computers. SaaS also makes it easier to have the same version of software on all of your devices at once by accessing it on the cloud. In the case of paid services, customers can access the services after paying the fees.

In a SaaS agreement, customers have the least control over the cloud. On the customer's side, there is no need for high investment in servers or software licenses, while for the provider, the costs are lowered, since only a single application needs to be hosted and maintained. Today SaaS is offered by companies such as Adobe for its image processing software Creative Cloud, Microsoft for its office software Office 365, facebook.com, etc.

2. Platform as a Service

A PaaS system goes a level above the Software as a Service setup. A PaaS provider gives subscribers access to the components that they require to develop and operate applications over the Internet. In other words, the platforms used to design, develop, build and test applications are provided by the cloud infrastructure. The customer

has the freedom to build his own applications, which run on the provider's infrastructure. To meet manageability and scalability requirements of the applications, PaaS providers offer a predefined combination of OS and application servers, such as LAMP platform (Linux, Apache, MySql and PHP), ASP.NET, PHP, Python, etc. Google's App Engine, Microsoft Azure, Force.com, etc. are some of the popular PaaS examples.

3. Infrastructure as a Service

An IaaS agreement, as the name states, deals primarily with computational infrastructure. IaaS provides basic storage and computing capabilities as standardised services over the network. Servers, storage systems, networking equipment, data centre space, etc. are pooled and made available to handle workloads. The customer would typically set up his own software on the infrastructure. Some common examples are Amazon Web Services,Joyent, AT&T, GoGrid, etc.

b. Advantages of cloud computing

The following are some benefits in the use of cloud computing:

Cost savings: Companies can reduce their capital expenditures and use operational expenditures for increasing their computing capabilities.

Scalability/Flexibility: Companies can start with a small deployment and grow to a large deployment fairly rapidly, and then scale back if necessary. Also, the flexibility of cloud computing allows companies to use extra resources at peak times, enabling them to satisfy consumer demands.

Reliability: Services using multiple redundant sites help in disaster recovery.

Maintenance: Cloud service providers do the system maintenance, thus reducing maintenance requirements.

Mobile accessible: Employees who travel as part of their job are also able to give better productivity since the systems they use are accessible from anywhere.

c. Disadvantages of cloud computing

Some of the challenges faced by those who use cloud computing are:

Security and privacy: Whenever data or a program is sent on a publicly accessible communication system and data is stored in a shared disk system, there is a danger of stealing or corrupting the data in the disk storage.

Lack of standards: Clouds have no standards and thus it is unlikely that most clouds are interoperable.

Know your progress

1. List the advantages of cluster computing.
2. What is cloud computing?
3. Name the different cloud service models.
4. What is Software as a Service?
5. Name any two SaaS providers.
6. Specify the names of any two providers of IaaS.

11.3 Artificial Intelligence

Artificial Intelligence (AI) is one of the latest disciplines in computer science and it was only in the 1950's that the first definition of artificial intelligence was established by Alan Turing. Turing studied how machinery could be used to mimic processes of the human brain. His studies resulted in one of the first publications of AI, entitled Intelligent Machinery. The term Artificial Intelligence was first coined in 1956 at the Dartmouth conference, organised by John MacCarthy. AI currently encompasses a huge variety of subfields, from general-purpose areas such as perception (insight) and logical reasoning, to specific tasks such as playing chess, proving mathematical theorems, computer vision, natural language processing, medical diagnosis, etc. Often, it is identified as an interdisciplinary area of research where scientists in other fields move gradually into AI, where they find the tools and vocabulary to systematise and automate the intellectual tasks on which they have been working. Similarly, researchers in AI can choose to apply their methods to any area of human intellectual endeavour. In this sense, it is truly a universal field.

Figure 11.9 represents the hierarchy of a knowledge pyramid. It is evident that the knowledge and intelligence that comes at the top of the pyramid are the major areas of study under AI. Here we have to simulate these on computers to make the system intelligent. While successes have been achieved in developing mathematical models of many biological systems including the models of the biological neurons, there are still no solutions to the complex problem of modelling intuition, consciousness and emotion which form integral parts of human intelligence.

Fig. 11.9: Knowledge pyramid

Alan Turing believed that machines that would mimic the processes of the human brain could be created. Turing strongly believed that a well-designed computer could do everything that a brain could. More than fifty years later his statements are still visionary.

The underlying thrust force behind every intelligent system is knowledge. At the base of the pyramid are symbols which form the basic means of representation. Data is termed as a collection of mere symbols. While processing data we get information, and knowledge is the organised information. It can be a piece of information that helps in decision making. The ability to draw useful inferences from the available knowledge is generally referred as intelligence. Wisdom is the maturity of mind that directs its intelligence to achieve desirable goals.

Here we will study how we can incorporate knowledge to a system and how this can be intelligently used to solve various real life problems which cannot be effectively solved with the help of conventional programming techniques. This is the basics of AI which can be defined as developing computer programs to solve complex problems by application of processes that are similar to human reasoning processes.

Turing Test approach to AI

The Turing Test, proposed by Alan Turing was designed to provide a satisfactory operational definition of intelligence. The details of the Turing Test is already detailed in Chapter 1 of Class XI. Turing defined intelligent behaviour as the ability to achieve human-level performance in all cognitive tasks, sufficient to fool an interrogator. Roughly speaking, the test he proposed is that the computer should be interrogated by a human via a teletype. The computer passes the test if the interrogator cannot distinguish between computer and a human being. A pictorial representation of Turing Test is given in Figure 11.10. As of today, Turing Test is the ultimate test a machine must pass in order to be called as intelligent and for now, programming a computer to pass the test provides plenty to work. In that case the computer would need to possess the following capabilities.

Fig. 11.10: Turing Test

- **Natural Language Processing (NLP):** To enable to communicate successfully in English (or some other regional language). Automatic speech recognition, speech synthesis, machine translation, handwritten character

recognition are some of the practical applications associated with NLP which deals with the methods of communicating with a computer in one's own natural language.

- **Knowledge representation:** To incorporate human knowledge before or during the interrogation.
- **Automated reasoning:** To use the knowledge to answer questions and to draw new conclusions.
- **Machine learning:** To adapt to new circumstances and to detect and deduce patterns.

The issue of acting like a human comes up primarily when AI programs have to interact with people say, when an expert system explains how it came to its diagnosis or a natural language processing system has a dialogue with a user. These programs must behave according to certain normal conventions of human interaction in order to make themselves understood. The underlying representation and reasoning in such a system may or may not be based on a human model. To pass the total Turing Test, the computer will also need the following:

- **Computer vision:** The capability to observe objects. If a machine has to have the capability of vision, it must also perform the activities including image acquisition, transformation, processing, analysis, understanding and interpretation.
- **Robotic activities** to move them about. To make the robot a little smarter, intelligence must be imbibed in it. To cope with the changing environment, intelligent sensors are to form a part of the robot which can sense the environment and supply necessary signals for its intelligent control unit.

The enormous successes achieved through the modelling of biologically inspired algorithms to simulate natural intelligence, resulted in the development of intelligent systems. These intelligent algorithms include Artificial Neural Networks (ANN), Evolutionary Computation (EC), Swarm Intelligence (SI) and Fuzzy logic. These intelligent algorithms form part of the field of AL

AI and Game Playing

Making computers play games had been one of the major goals of research in computer science, especially in AI. Shannon's paper on chess-playing program and Samuel's Checkers are considered as landmark in this area. The reason why game playing occupies a important role in AI are follows:

- **The rules of the game are limited. Hence extensive amounts of domain-specific knowledge are seldom needed.**

- Many human experts exist to assist in the development of the programs.
- Games provide a structured task where success and failure can be measured with least effort.
- For human experts, it is easy to explain the rationale for a move unlike other areas.
- Game-playing permits one to simulate real-life situations.

Deep Blue from IBM beat Kasparov in 1997. The system that beat Kasparov was highly optimized, with an extensive knowledge base on chess game.

11.4 Computational Intelligence

From ancient times, we have started using different types of machines to get our work done. We choose machines based on the nature of job to be done. With the invention of digital computers, time consuming and error-prone numeric computations are done with relative ease and accuracy. Then we thought of seeking help of computers in reasoning processing. The seed for this was sown by Allan Turing. Today the design of algorithmic models to solve increasingly complex real life problems using computers is considered as a major challenge.

Since we have started using machines, especially digital computers, to solve our real life problems, human-machine interaction became an interesting area of study and the outcomes of such studies resulted in the development of new branch of discipline known as Cybernetics. Cybernetics is defined as the study of control and communication between man and machines. For example, these studies led to the development of automatic unmanned navigation systems for spacecraft, computers that can take orders in natural language speech or as handwriting inputs and smart weapons like guided nuclear missiles, etc. Computational Intelligence (CI) combines elements of learning, adaptation, evolution and fuzzy linguistic to create programs that are, in some sense, intelligent. Computational Intelligence experts focus on problems that are difficult to solve using artificial systems, but are solved by humans and some animals using intelligence.

A more recent definition of artificial intelligence stated that it is the study of how to make computers do things which people are doing better. AI can be seen as a combination of several research disciplines like computer science, biology, medicine, robotics, etc.

11.4.1 Computational Intelligence paradigms

Computational Intelligence (CI) is the study of adaptive mechanisms (algorithms) to facilitate intelligent behaviour in complex and changing environments so as to solve real life problems. These mechanisms include AI paradigms that exhibit an ability to learn or adapt to new situations and CI paradigms like Artificial Neural Networks (ANN), Evolutionary Computation (EC), Swarm Intelligence (SI) and Fuzzy Systems (FS). While individual techniques from these CI paradigms have been applied successfully to solve real-world problems, the current trend is to develop hybrids of paradigms, since no one paradigm is superior to the others in all situations. We do this to capitalise on the respective strengths of the components of the hybrid CI system, and eliminate weaknesses of individual components. Here we consider four main paradigms of Computation Intelligence (Cl), namely Artificial Neural Networks (ANN), Evolutionary Computation (EC), Swarm Intelligence (SI), and Fuzzy Systems (FS).

Soft computing

According to Lotfi. A. Zadeh, professor emeritus of computer science at **the University of California, soft computing is an emerging approach to computing which parallels the remarkable ability of the human mind to reason and learn in an environment of uncertainty and imprecision. It is also identified as a different grouping of paradigms, which usually refers to the collective set of CI paradigms and probabilistic methods. It is also possible that the techniques from different paradigms can be combined to form hybrid systems as well. Soft computing is tolerant of imprecision, uncertainty, partial truth, and approximation. In effect, the role model for soft computing is the human brain. Soft computing is a group of methodologies that works synergistically and provides flexible information processing capability for handling real-life ambiguous situations.**

It is very interesting to understand that each of the above mentioned CI paradigms has its origins in biological systems. Artificial Neural Networks (ANNs) model biological neural systems, Evolutionary Computing (EC) models natural evolution (including genetic and behavioural evolution), Swam Intelligence (SI) models the social behaviour of organisms living in swarms or colonies, and Fuzzy Systems (FS) originated from studies of how organisms interact with their environment and respond to the uncertain, imprecise, or fuzzy inputs.

A. Artificial Neural Networks

The brain is a complex, nonlinear and parallel computer. It has the ability to perform tasks such as pattern recognition, perception and motor control (body movements)

much faster than any computer - even though events occur in the nanosecond range for silicon gates and milliseconds for neural systems. In addition to these characteristics, others such as the ability to learn, memorise and still generalise, prompted research in algorithmic modelling of biological neural systems - referred to as Artificial Neural Networks (ANN).

It is estimated that there is in the order of 10-500 billion neurons in the human cortex (brain's outer layer of neural tissue in humans), with 60 trillion synapses (a synapse is a structure that permits a neuron to pass an electrical or chemical signal to another cell). The neurons are arranged in approximately 1000 main modules, each having about 500 neural networks. Current successes in neural modelling are for small ANN s aimed at solving a specific task.

B. Evolutionary Computation

Evolutionary Computation (EC) has its objective to mimic processes from natural evolution, where the main concept is survival of the fittest, i.e., the weak must die. In natural evolution, survival is achieved through reproduction. Offspring, reproduced from two parents (sometimes more than two), contain genetic material of both (or all) parents - hopefully the best characteristics of each parent. Those individuals that inherit bad characteristics are weak and lose the battle to survive. This is nicely illustrated in some bird species where one offspring manages to get more food, gets stronger and at the end kicks out all its siblings from the nest to die.

Evolutionary algorithms use a population of individuals, where an individual is referred to as a chromosome. A chromosome defines the characteristics of individuals in the population. Each characteristic is referred to as a gene. The value of a gene is referred to as an allele. For each generation, individuals compete to reproduce offspring.

Those individuals with the best survival capabilities have the best chance to reproduce. Offsprings are generated by combining parts of the parents, a process referred to as crossover. Each individual in the population can also undergo mutation which alters some of the allele of the chromosome. The survival strength of an individual is measured using a fitness function which reflects the objectives and constraints of the problem to be solved.

Evolutionary computation has been used successfully in real-world applications like, data mining, fault diagnosis, classification, scheduling, etc.

C. Swarm Intelligence

Swarm intelligence (SI) originated from the study of colonies or swarms of social organisms (Figure **11.11**). Studies of the social behaviour of organisms (individuals) in swarms prompted the design of very efficient algorithms. For example, simulation studies of the graceful, but unpredictable, choreography of bird flocks led to the design of the particle swarm optimisation algorithm and studies of the foraging behaviour of ants resulted in ant colony optimization algorithms.

Fig. 11.11: Swarm of ants

#s — ach—tzommo

Machine learning is the study of mechanisms that allow a machine to infer complex patterns and behaviors from empirical data. Machine learning is used extensively in image and speech recognition, as well as in data-mining applications. Though the CI techniques are similar in nature, the main difference is that the core representation of knowledge in machine learning is statistical, whereas the core representation of knowledge in computational intelligence is approximate in nature (fuzzy).

D. Fuzzy systems

Traditional set theory requires elements to be either part of a set or not. Similarly, binary valued logic requires the values of parameters to be either 0 or **1.** Human reasoning is, however, almost always not this exact. Our observations and reasoning usually include a measure of uncertainty. For example, humans are capable of understanding the sentence: "Some Computer Science students can program in most languages". But how can a computer represent and reason with this fact? Fuzzy sets and fuzzy logic allow what is referred to as approximate reasoning. With fuzzy sets, an element belongs to a set to a certain degree of certainty. Fuzzy logic allows reasoning with these uncertain facts to infer new facts, with a degree of certainty associated with each fact. In a sense, fuzzy sets and logic allow the modelling of common sense.

Fuzzy systems have been applied successfully to control gear transmission and raking systems in vehicles, controlling lifts, home appliances, controlling traffic signals, etc.

11.4.2 Application of Computational Intelligence

Computational intelligence (commonly referred to as Artificial Intelligence) is a very broad interdisciplinary field which has roots in and intersects with many domains, not only the computing disciplines, but also mathematics, linguistics, psychology, neuroscience, mechanical engineering, statistics, economics, control theory and cybernetics, philosophy, and many others. The latest applications of Computational Intelligence are now being explored. Here we will discuss some of the widespread applications of CI.

A. Biometrics

Biometrics refers to metrics (measurements) related to human characteristics and traits. Biometrics authentication is used in identification of individual. Biometric identifiers are the distinctive, measurable characteristics used to label and describe individuals.

Physiological characteristics are related to the physical shape or characteristics of the body. They include fingerprint, palm veins, face, hand geometry, iris, retina and odour/scent. Behavioral characteristics are related to the pattern of behavior of a person. They include typing rhythm, speed and voice.

Biometric identification is popularly used in attendance management systems, authentication in computers and other devices, Aadhar cards, etc. Figure 11.12 shows the applications of biometrics.

Fig. 11.12: Finger print and retina identification

B. Robotics

Robot is an electromechanical device which is capable of reacting in some way to its environment and take autonomous decisions or actions in order to achieve a specific task. Robotics can be defined as the scientific study associated with the design, fabrication, theory and application of robots. Robotics is a multi-disciplinary branch which spans over mechanical engineering, electrical engineering and computer

science. It includes the design, construction, operation and application of robots as well as computer systems for their control, sensory feedback and information processing. Figure 11.13 shows some of the applications of robots.

Fig. 11.13: Robots in a car assembly, agriculture fields and a military drone

Today robots are popularly used in several areas like vehicle industry, outer space, military, etc. Let us discuss some of them.

Uses in vehicle manufacturing industry: Robotic arms are used in the vehicle manufacturing process. Robotic arms are able to perform multiple tasks such as welding, cutting, lifting, sorting and bending.

Exploration of outer space: Manipulative arms that are controlled by a human are used to unload the docking bay of space shuttles to launch satellites or to construct a space station.

In intelligent homes: Automated systems can now monitor home security, environmental conditions and energy usage. Door and windows can be opened automatically and appliances such as lighting and air conditioning can be pre• programmed to be activated.

Exploration in difficult environments: Robots can visit environments that are harmful to humans. An example is monitoring the environment inside a volcano or exploring our deepest oceans. NASA has used robotic probes for planetary exploration since the early sixties.

Uses in military: Nowadays airborne robots (drones) are used by modern armies. Today drones are mostly used for surveillance purpose. Drones are also used for aerial attacking in hostile environment. In the future automated aircraft and vehicles could be used to carry fuel and ammunition or clear minefields.

Uses in agriculture: In developed countries large farms use automated harvesters that can cut and gather crops. Robotic dairies allow operators to feed and milk animals remotely.

The word 'robotics' was first used in Runaround, a short story published in 1942, by Isaac Asimov, an American author and a professor of biochemistry. The word robot comes from the Czech word 'robota' which means "compulsory doing manual work without receiving any remuneration".

C. Computer vision

Computer vision is the construction of explicit, meaningful descriptions of the structure and the properties of the 3-dimensional world from 2-dimensional images. Computer vision acquires 3 dimensional shape and other properties of objects based on their two dimensional (projection) images through the use of computers and cameras. It is also called image understanding. The purpose of this branch is allowing computers to understand the physical world by visual media means. The image data can take many forms, such as video sequences, views from multiple cameras or multi-dimensional data from a medical scanner.

Computer vision was initially developed for military applications. It is an important component of artificial intelligence and robotics. Sub-domains of computer vision include scene reconstruction, event detection, video tracking, object recognition, learning, indexing, motion estimation, and image restoration. Figure **11.14** displays the image of Mars rover - Curiosity which uses computer vision to explore Mars.

Fig. 11.14: Mars Rover - Curiosity

D. Natural Language Processing

Natural languages are the languages which are spoken by the people. Natural Language Processing (NLP) is the branch of computer science focused on developing systems that allow computers to communicate with people using any human language such as English, Malayalam, etc. Natural Language Processing (NLP) is a subfield of Artificial Intelligence (AI). It allows people to interact with computers without any specialised knowledge. This implies that anybody can simply talk to the computer in their own language. There is no need to learn any programming language. We know that language is a set of symbols and rules. Symbols are combined to convey new information. Rules govern the manipulation of symbols. We call these rules grammar of the particular language. But developing computer programs that can understand natural languages is a difficult task.

NLP computer does two things. Natural Language Understanding (NLU) and Natural Language Generation (NLG). Natural Language Understanding is about understanding and reasoning the input, which is any natural language like English, Malayalam, etc. Natural Language Generation deals with creation of output. Apart from NLP there are voice recognition systems that can convert spoken sounds into written words.

Compared to the international scenario, Natural Language processing in India is in its infancy stage. India, as a multilingual country realised its prospects and Department of Electronics (DOE), Govt. of India under the Technology Development for Indian Languages (TDIL) program has initiated development of NLP based tools.

E. Automatic Speech Recognition

Natural language processing (NLP) refers to artificial intelligence methods of communicating with a computer in a natural language like Malayalam. Automatic speech recognition (ASR) is one of the fastest growing and commercially most promising applications of natural language processing technology. Communication among human beings is dominated by spoken language. Therefore, it is natural for people to expect speech interfaces with computers which can speak and recognize speech in native language. This can be accomplished by developing an Automatic Speech Recognition (ASR) system which allows a computer to identify the words that a person speaks into a microphone or telephone and convert it into written text. As a result it has the potential of being an important mode of interaction between human and computers. Although any task that involves interfacing with a computer can potentially use ASR. The ASR system would support many valuable applications like dictation, command and control, voice dialing, spoken database querying, office dictation devices, and automatic voice translation into foreign languages etc. Figure 11.15 shows a sample interaction between a human and a computer through ASR.

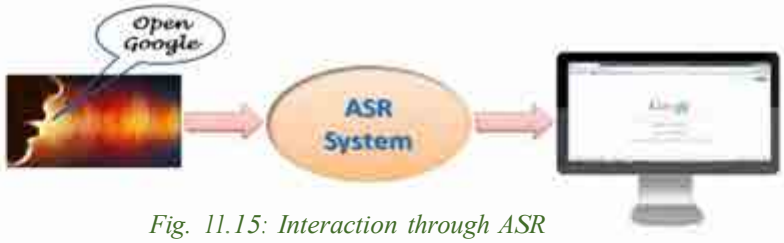


Fig. 11.15: Interaction through ASR

The mobile applications Siri which is a part of AppleiOS, Cortana of Microsoft Phone and Google Now of Android are intelligent personal assistants which can answer oral questions, make recommendations and perform actions on the mobile phone .

F. Optical Character Recognition and Handwritten Character Recognition Systems

Our visual system is capable to recognize image patterns in an impressively fast and accurate way. We recognize various patterns and objects in the daily environment without much effort. The task of Optical Character Recognition (OCR) and Handwritten Character Recognition (HCR) in a more general context are integral parts of pattern recognition. At the early stages of research and development of pattern recognition most of the research involved in the work of OCR. This software converts the scanned images of printed text (numerals, letters or symbols) into computer processable format (such as ASCII). At present, reasonably good OCR packages are available for most of the languages.

Automatic recognition of handwritten text was regarded as an important and challenging research area by scientists and engineers even before the advent of modern electronic computers. According to the way in which handwriting data is generated, two different approaches are present in HCR: on-line and off-line. In the former, the data are captured during the writing process by a special pen on an electronic surface as shown in Figure 11.16. In the latter, the data are acquired by a scanner after the writing process is over.

Many promising research results are reported in the area of handwritten character recognition for many foreign and Indian languages. Google's online handwriting recognition application 'google handwriting input' can recognise handwritten scripts of 82 languages in mobile devices.

Fig. 11.16: Handwritten recognition system

G. Bioinformatics

Bioinformatics is the application of computer technology to the management of biological information. Computers are used to gather, store, analyse and integrate biological and genetic information which can then be applied to gene-based drug discovery and development. The need for bioinformatics capabilities has been accelerated by the explosion of publicly available genomic information resulting from the Human Genome Project.

The aims of bioinformatics are three-fold. First, bioinformatics organises data in a way that allows researchers to access existing information and to submit new entries as they are produced. The second aim is to develop tools and resources that aid in the analysis of data. The third aim is to use these tools to analyse the data and interpret the results in a biologically meaningful manner.

Human Genome Project

The Human Genome Project was an effort aimed to determine the sequence of the human genome and identify the genes that it contains. All our genes together are known as our "genome". The Project was coordinated by the National Institutes of Health and the United States Department of Energy. The Human Genome Project has helped researchers understand the blueprint of an individual. This research with the extensive use of computing revealed much about the functions of genes and proteins. This knowledge will have a major impact in the fields of medicine, biotechnology and the life sciences.

H. Geographic Information System

We know that there are large number of satellites revolving around the earth. They have designed, built and launched in order to relay images of our planet back to earth. Remotely sensed information is the most widely used one in the application of urban, agriculture, disaster monitoring, oil spill monitoring, etc. Geographic Information System (GIS) technology is developed from digital cartography and Computer Aided Design (CAD) database management system.

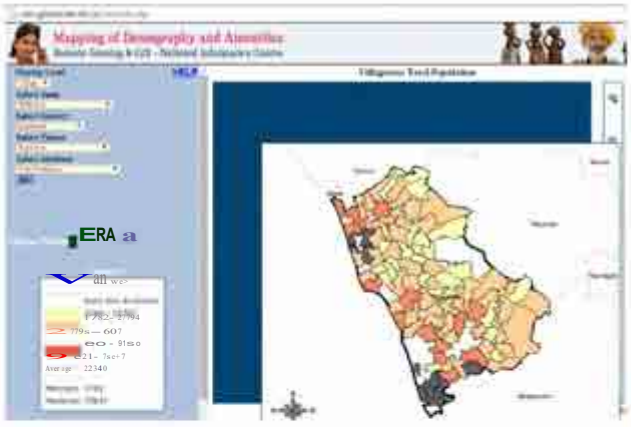


Fig. 11.17a: Mapping population in Kozhikode through GJS

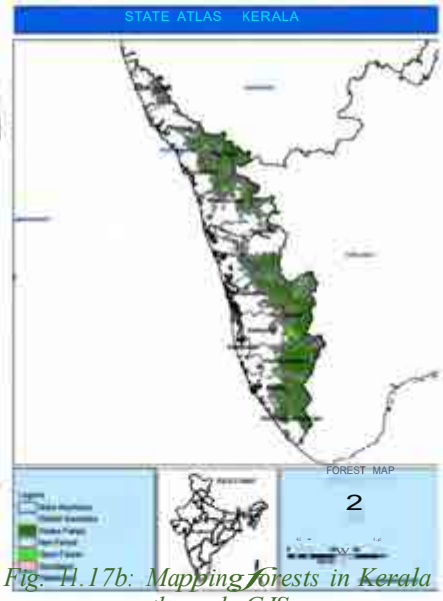


Fig. 11.17b: Mapping forests in Kerala through GJS

GIS is a computer system for capturing, storing, checking and displaying data related to various positions on earth's surface. GIS can show many different kinds of data on a map. This enables people to easily see, analyse and understand patterns and relationships. Figure 11.17 shows the plotting of total population of each village in Kozhikode district.

GIS can be applied in various areas like soil mapping, agricultural mapping, forest mapping, e-Governance, water resource management, natural disaster assessment, etc. The benefits of GIS are better information management, higher quality analysis, ability to carry out 'what if' scenarios, improve project efficiency. GIS applications are also used in planning process for sustainable development including strategic urban planning, infrastructure planning, precision agriculture planning, etc.

Remote sensing

Remote sensing means sensing things from a distance. Remote sensing is the art and science of obtaining information about an object without being in direct contact with the object.

In satellite remote sensing, sensors are used for capturing radiation from many different parts of electromagnetic spectrum which are visible to human eye. This technology is used to extract information about the features and objects on the earth's surface, oceans and atmosphere.

Let us consider the case of weather forecasting. Weather satellites carry instruments called radiometers (not cameras) that can scan the earth to form images. Analysing these data, our meteorologists predict weather. Besides temperature and rain our meteorologists can also predict the possibilities of earthquake, whirlwind, hurricane, etc. In our country India Meteorological Department is setup for this purpose. It is an agency of the Ministry of Earth Sciences of the Government of India. It is the principal agency responsible for meteorological observations, weather forecasting and seismology. Figure 11.18 shows the satellite image for the cyclonic storm HudHud gathering over Bay of Bengal during October 2014.

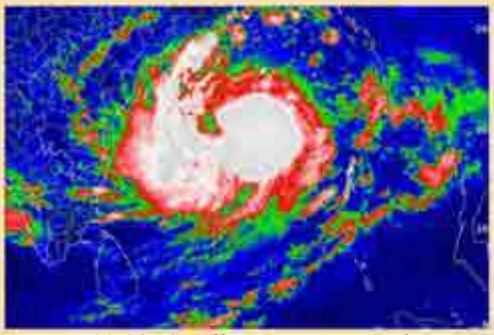


Fig.11.18: Satellite image of cyclone HudHud over Bay of Bengal

Know your progress

1. What is the differenve between OCR and H CR systems?
2. What do you mean by GIS?
3. The scientific study associated with the design, fabrication, theory, and application of robots are called _____ .
4. What is Natural Language Processing?
5. Give an example where computer vision is used.
6. ANN is _____ .

Let us conclude

Recent migrations to distributed computing platforms have increased the need for a better understanding of network computing. Distributed platforms may be connected in a variety of ways ranging from geographically dispersed networks to architecture specific interconnection structures. In parallel computing a problem will be subdivided among the various CPUs. Clusters aggregate many machines into a large, centrally managed entity. Grid computing allows each node to access resources on other nodes as if they were local. Cloud computing refers to applications and services offered over the Internet. Whatever be the choice, it is clear that as processor power becomes less expensive and available through some type of high-speed network will become a standard part of computing in the future. Artificial intelligence is the intelligence exhibited by machines or software. It is an academic field which studies the goal of creating intelligence. GIS is a software system mainly used to help in planning and organising geographic data. Remote sensing is the acquisition of information about an object or phenomenon without making physical contact with the object and thus in contrast to on site observation. Remote sensing is used in various fields such as agriculture, forestry, geology, meteorology, etc.

Let us assess

1. Explain the features of distributed computing.
2. Compare parallel and serial computing.
3. The distributed computing paradigm that uses existing hardware is _____.
4. List advantages of cluster computing.

5. Explain how cloud service models change the way we use computers.
6. Give examples for companies that offer SaaS.
7. List the advantages and limitations of cloud computing.
8. Draw and explain the knowledge pyramid.
9. What is Computational Intelligence?
10. Define Cybernetics?
11. The test used to decide whether a machine is intelligent or not is called _____
12. What is ANN?
13. Explain Swarm Intelligence.
14. Explain Fuzzy Systems.
15. List some uses of biometrics.
16. Write the uses of robotics.

12 ICT and Society

ARE

After the completion of this chapter the learner:

- lists the facilities in e-Govemance, e-Business, e-Learning.
- explains the tools used in e-Learning.
- lists various advantages and challenges faced in implementing e-Governance, e-Business, e-Learning applications.
- uses some of the useful websites in each area.
- explains cyberspace.
- distinguishes different types of cyber crimes.
- lists and explains various intellectual property rights.
- details cyber law and ethics.
- identifies the importance of IT Act.
- recognisesinfomania

The use of Internet has increased rapidly in the last few decades. The modern society cannot think of a day without the Internet and different services provided by it. How could we think of banking without ATM, business without e• commerce, hospitals without latest computer based diagnosis system, education without IT enabled tools, etc. Surely Information and Communication Technology has made life easier. We also learned that Internet has become the largest communication media. Social media has made great impact on the society. E-Governance has opened new ways to deliver government service to its citizen. Business transactions made easier by e• commerce and e-Learning widens the new horizon in the learning and teaching field.

Information and Communication Technology (ICT) is the term often used as an extended synonym for Information Technology (IT). ICT is more specific in integrating telecommunication and computers comprising of many technologies for capturing, storing, processing, interpreting and printing information.

Similar to rights on property like land, house, etc., intellectual properties like music, films,

software, designs, etc. also have ownership rights. These rights called Intellectual Property Rights and the issues related to them are discussed in this chapter. Every technology has a dark side. Internet also has its share of issues and threats. Many people use this medium for performing illegal activities. We will discuss about such actions and how we can safeguard in Internet.

12.1 ICT services

Popularity of Information Technology (IT) has increased the number of services that are available with the help of computers and communication technology. Here we discuss a few services that have changed the procedure of attending such services.

12.1.1 e-Governance

Information Technology (IT) has contributed much to the smooth functioning of governments. It comprises many technologies for capturing, processing, interpreting, storing and transmitting information. IT helps governments to take quick and judicious decisions. It also increases transparency and accountability in all its services. Information and Communication Technology (ICT) aided Governance is generally known as e-Governance.

e-Governance is the application of ICT for delivering Government services to citizens in a convenient, efficient and transparent manner. The objective of e• Governance is to ensure that the services of the Government reach the public promptly and effectively. In Kerala, we have many government departments like the Motor Vehicle Department, Education, Revenue, etc. which have successfully implemented e-Governance. Let us now discuss various types of interactions in e• Governance.

A. Types of interactions in e-Governance

e-Governance facilitates interaction among different stakeholders in governance. Categories of these interactions are described as follows:

Government to Government (G2G) -It is the electronic sharing of data and/or information among government agencies, departments or organisations. The goal of G2G is to support e-Governance initiatives by improving communication, data access and data sharing.

Government to Citizens (G2C)–It creates an interface between the government and citizens. Here the citizens enjoy a large range of public services. It increases the availability and accessibility of public services. It also improves the quality of services. Its primary purpose is to make the government citizen-friendly.

Government to Business (G2B) - Here, e-Governance tools are used to aid the business community to interact with the government. The objective is to cut red-

tapism, save time, reduce operational costs and create a more transparent business environment while dealing with the government.

Government to Employees (G2E) - Government, being the biggest employer has to interact with its employees on a regular basis. This interaction is a two-way process between the government and the employees. The policies and guidelines for implementing various government programmes are made available to the employees as government orders or circulars through e-Governance portals. The salary and personal details of government employees are also managed through e• Governance services. Use of ICT tools helps in making these interactions fast and efficient.

B. e-Governance infrastructure

In India, thee-Governance infrastructure mainly consists of State Data Centers (SDC) for providing core infrastructure and storage, State Wide Area Network (SWAN) for connectivity and Common Service Centers (CSC) as service delivery points. The integration of these three components of e-Governance is shown in Figure 12.1.

i. State Data Centre (SOC)

State Data Centre (SDC) is one of the important constituents of the core infrastructure for supporting e-Governance initiatives of National e-Governance Plan (NeGP). Under NeGP, it is proposed to create SDCs to combine services, applications and infrastructure and to provide efficient electronic delivery of G2G, G2C and G2B services. These services can be rendered by each state government through a common delivery platform. This platform is supported by a core connectivity infrastructure such as State Wide Area Network (SWAN) and Common Service Centre (CSC) connectivity that is extended up to the village level. State Data Centre provides several functionalities. These include keeping central data repository of the state, securing data storage, online delivery of services, citizen information/ services portal, state intranet portal, disaster recovery, etc. SDCs also provide better operation and management control and minimize the overall cost of data management, resource management, deployment etc.

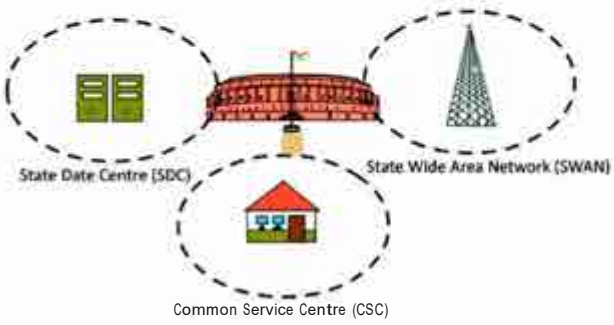


Fig. 12.1: e-Governance infrastructure

rm

ii. Kerala State Wide Area Network (KSWAN)

Kerala State Wide Area Network (KSWAN) has been set up as a backbone of the State Information Infrastructure (SIi). It connects Thiruvananthapuram, Kochi and Kozhikode as its hubs and extends to all the 14 districts linking each of the 152 Block Panchayats. The network also connects a large number of various offices of government departments. The infrastructure supports the integration of a large number of G2G, G2C services with the applications received from the State Data Centre.

iii. Common Service Centre (CSC)

Common Service Centres (CSC) are the front-end delivery points of the government, private and social sector services for the rural citizens of India. A highlight of the CSCs is that it offers web-enabled e-Governance services in rural areas. It helps in utility payments such as electricity, telephone and water bills, submission of online applications and generating and distributing the certificates to the needy. Other services that could be offered through CSC are listed below:

- Agriculture services
- Education and training services
- Health services
- Rural banking and insurance services
- Entertainment services
- Commercial services

In Kerala Akshaya centres are working as Common Service Centres.

Akshaya centres

Akshaya centres were initially launched in the year 2002 in the Malappuram district in Kerala. Its intention was to impart e-Literacy to the citizens. Akshaya was conceived as a landmark ICT project by the Kerala State Information Technology Mission (KSITM) to bridge the digital divide and to bring the benefits ofICT to the entire population of the State. The services include e-grantz, e-filing, e-district, e-ticketing, submitting online application for ration card and electoral ID, Aadhaar enrolment, Aadhaar based services, insurance and banking services.

Akshaya was launched on 18" November 2002 by the former President of India, Dr. A. P. J. Abdul Kalam. Akshaya works in the PPP (Private Public Partnership) Model. An Akshaya centre is owned by a private entrepreneur preferrably from the same panchayath where the Akshaya centre is located and its selection is done by local self governments. The income for the Akshaya Entrepreneurs is the nominal service charge collected either from the citizen or paid by the government for each transaction.

Aadhaar is a 12 digit individual identification number issued as part of e-Governance by the Unique Identification Authority of India (UIDAI) on behalf of the Government of India. This number will serve as a proof of identity and address, anywhere in India. Any individual, irrespective of age and gender, who is a resident in India, can enroll in Aadhaar. Each individual needs to enrol only once which is free of cost. During the enrolment, demographic details (name, age, gender and address) and biometric details (photo, 10-finger- print and 2-iris-images) of a resident are entered. Each Aadhaar number will be unique to an individual and will remain valid throughout life. Aadhaar number will help you provide access to services like banking, taking mobile phone connections and other Government and Non-Government services.

C. Benefits of e-Governance

Implementing e-Governance has many advantages. It informs the public about the functioning of the government and the policies they are trying to implement. Major benefits of e-Governance are listed below:

- e-Governance leads to automation of governement services, ensuring the information regarding the activities of public welfare is easily available to all citizens.
- e-Governance strengthens the democracy by ensuring greater participation of citizens at all levels of governance.
- It ensures more transparency in the functioning and thus helps eliminate corruption.
- It makes every government department responsible as they know that they are closely observed.
- Proper implementation of e-Governance saves unnecessary visits of the public to offices. It saves time and money.

D. Challenges to e-Governance

Though e-Governance has many benefits, it faces some challenges too. Let us have a look at a few challenges in the implementation of e-Governance.

- The existing digital divide is an obstacle in utilising the services of e-Governance. Those who live in remote areas with lower e-Literacy will face difficulty to access the services of e-Governance.
- e-Governance applications being computer/web based, security measures are highly required since there is possibility of cyber-attack.

- Usually a huge initial investment and planning are required for the proper implementation and maintenance of e-Governance services.
- Many people are anxious about the sharing of their personal information, biometry, etc. to the agencies designated for data collection.
- Integrity of various departments is very much essential for the efficiency and effectiveness of e-Governance.

E. Useful e-Governance websites

Table 12.1 shows the addresses of some websites that provide various services of the Government of Kerala. Figure 12.2 shows the home page of the Department of Higher Secondary Education, Kerala State and Figure 12.3 shows the home page of e-District portal.

Address of website	Purpose/Service
www.dhsekerala.gov.in	An official site of the Department of Higher Secondary Education, Government of Kerala that provides various facilities and services to students, teachers and school administrators.
www.edistrict.kerala.gov.in	It provides government services to the public.
www.incometaxindia.gov.in	It provides the services of Income Tax department.
www.keralamvd.gov.in	It is the official website of the Motor Vehicles Department of Kerala.
www.rti.gov.in	Right to Information Act 2005 mandates timely response to a citizen who requests for information from the Government or authorities under it.
www.itmission.kerala.gov.in	It is a Government of Kerala site which provides managerial support to various IT initiatives.
www.spark.gov.in	It is a web based G2E integrated solution for Service and Payroll Management.

Table 12.1: Some e-Governance websites

Fig. 12.2: The home page of DHSE website

www.dhsekerala.gov.in

As an official site of the Department of Higher Secondary Education, Government of Kerala, www.dhsekerala.gov.in provides various facilities and services to students, teachers and school administrators. The services include registration for the examinations, issue of hall tickets, publication of exam results, distribution of various circulars and notifications, etc. This site also provides facilities for downloading various forms and study materials including model question papers.

Fig. 12.3: The home page of e-District portal

e-District is a State Mission Mode Project under the National e-Governance plan. The project aims at supporting computerisation for services to the public.

In Kerala, issue of different certificates of the Department of Revenue is integrated with thee-District portal. It has simplified all complex procedures in government offices and made the citizens' life easy. It has been a difficult task for the citizen to obtain copies of public records, submit applications, meet officials, or to seek information regarding their day-to-day needs. This has caused the loss of his/her day's income, time as well as the cost of transportation. At government offices, sometimes, the relevant record, information, or official may not be available, resulting in repeated visits and additional expenses.

To avail a service in e-District, one has to apply online through the web portal or approach a nearby Akshaya centre with essential documents. Akshaya centre submits an online application on behalf of the citizen. This application through a work-flow reaches the village officer. After processing the application, the village officer forwards it to the next higher authority or approves it and issues the certificate using the digital signature. The availability of the certificate in the portal is informed with an SMS alert.

Know your progress

1. Name the application of Information and Communication Technology (ICT) for delivering government services to the citizens in a convenient, efficient and transparent manner.
2. Define the term e-Governance.
3. "e-Governance facilitates interaction between different stakeholders in governance". Say whether the statement is True or False.
4. Give an example for an e-Governance website.
5. What is KSWAN?

12.1.2 e-Business

We often visit shopping places and it takes a considerable amount of time and effort for shopping. What about the idea of shopping without leaving your home? It is one of the realities of the times. Almost all services and business are available online now. They are only a few clicks away.

e-Business is the sharing of business information, maintainin g business relationships and conducting business transactions by means ofthe ICT application. Companies

(business), public institutions (administration), as well as individuals (consumer) engage in e-Business. e-Business helps in effective e-marketing and increasing sales through effective use of e-Commerce services. It also reduces communication and travel cost through online meeting and shared workspace, etc.

A. e-Commerce and e-Business

Although the terms e-Commerce and e-Business are often used interchangeably there are differences. e-Commerce covers business transaction that involve exchange of money, whereas e-Business includes all aspects of running a business such as marketing, obtaining raw materials or goods, customer education, looking for suppliers etc. Thus e-Business is an extension of e-Commerce.

B. Electronic Payment System (EPS)

Can you think of living without money in your pocket? If somebody tells that he/she lived a week without touching currency notes, will you believe? Today we live in a world where almost every commodity has a price tag attached to it. Then how is it possible to buy something without giving money, the paper currency?

Electronic Payment System (EPS) is the solution. When we move on to electronic business, exchange of money also needs to be electronic. It is both convenient and secure if properly implemented. EPS plays an important role in e-Business.

A system of financial exchange between buyers and sellers in an online environment is called an Electronic Payment System (EPS). The financial exchange is facilitated by a digital financial instrument (such as credit/debit card, electronic cheque or digital cash) backed by a bank and/or an intermediary.

C. e-Banking

Banking has also undergone drastic changes with the advancements in Information Technology. Our traditional concept of banking has changed a lot. For example, now there is no need to visit bank for making financial transactions. We can do the transaction using online banking facilities even while travelling. Facilities such as ATM, debit cards, credit cards, Internet banking and core banking help in transforming traditional banking into e-Banking. e-Banking or electronic banking is defined as the automated delivery of banking services directly to customers through electronic channel. It can access data without geographical limitations.

D. Advantages of e-Business

e-Business provides many advantages to customers and firms. Let us discuss some of the major advantages of using e-Business applications.

- It overcomes geographical limitations. If you have a physical store, you are limited by the geographical area where you can provide service. But with e• Commerce, this limitation can be overcome.

- e-Business reduces the operational cost. An e-Commerce merchant does not need a prominent physical location; it reduces the operational cost. A portion of money thus saved can be passed on to the customers in the form of discounts.
- It minimises travel time and cost. Sometimes customers have to travel long distances to reach their preferred store. e-Business allows them to visit the same store virtually.
- It remains open all the time. e-Business application services are always open (24X7). From the merchant's point of view, it increases the number of service requests they receive. From the customer's point of view an 'always open' store is more convenient.
- We can locate the product quicker from a wider range of choices. On an e-Business website the consumers can have a wider range of choices of a product from various sellers. Customers can quickly locate their preferences from the given product lists. Some websites remember customer preferences and shopping lists to facilitate repeat purchase. The features like product characteristics and price comparisons are the other attractions of e-Business applications.

The term M-Business or mobile business covers all the business activities, processes and applications performed by means of mobile devices such as mobile phone, PDA, etc. M- Business can be regarded as a branch of e-Business.

e-tailing (or electronic retailing) is the selling of retail goods on the Internet. It is the most common form of business-to-consumer (B2C) transaction.

E. Challenges toe-Business

Though e-Business has enormous potential in the business world, it faces many challenges, particularly in developing countries like India. Major challenges are discussed below:

- A good percentage of the population is unaware of IT applications and its uses. Surprisingly, most of the regular Internet users also lack knowledge about online business and its possibilities.
- Most of the customers, especially to rural population, do not possess plastic money- credit card, debit card and net banking system, which is necessary for e-Business.
- If not used with caution, customers may lose valuable information like their credit card number, passwords, etc.

- Products like apparel, handicrafts, jewellery, etc are often purchased after examining physically. But in online shopping, customers don't have this 'touch and feel' advantage.
- For the success of e-Business of any organisation or company, perfect and efficient shipment service is a necessity.

F. Useful e-Business websites

Some popular e-Business websites are given in Table 12.2. Figure 12.4 and 12.5 are the home pages of some e-Business websites.

Address of website	Purpose/Service
www.irctc.co.in	Indian Railway Catering and Tourism Corporation Limited web site for reservation and cancellation of railway tickets and hotels for accommodation.
www.amazon.com	US based retailer with headquarters in Washington.
www.ebay.in	It is one of the largest online shopping sites in India.
www.licindia.com	Insurance company website.
www.airindia.com	Online site for booking Air India flight tickets.
www.keralartc.com	Online website for KSRTC bus ticket booking.
www.bookmyshow.com	Movies and theatre ticket booking website.

Table 12.2: Some e-Governance websites

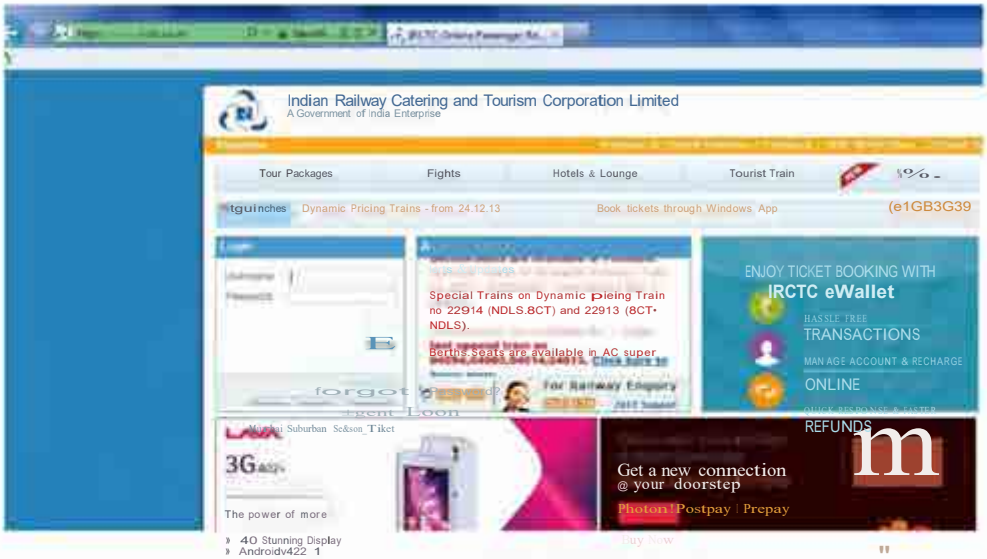


Fig. 12.4: The home page of www.irctc.co.in

www.irctc.co.in

Indian Railway Catering and Tourism Corporation Limited (IRCTC) is a government of India enterprise. It handles the catering ,tourism and online ticketing operations of the railways. IRCTC provides online booking facilities of railway tickets and offers other services like checking reservation status, train timing, reservation of hotels for the tourists across the country.

Fig 12.5: The home page of amazon. in

www.amazon.com

amazon.com, Inc is a US based company with headquarters in Washington. It is the world's largest retailer. Initially started as an online bookstore it soon diversified itself into selling software, video games, electronics, furniture, food, toys, jewellery, etc. The company also produces consumer electronics. Amazon has separate retail websites for different countries. In 2013, Amazon launched its site for India, www.amazon.in.

Know your progress

1. The system of financial exchange between buyers and sellers in an online environment is known as _____
2. Define e-Business.
3. Define e-Banking.
4. Check whether the following statement is true or false.

   "e-Business is an extension of e-Commerce".

12.1.3 e-Learning

We are familiar with the traditional classroom consisting of a teacher, students, teaching aids, etc. Think of a virtual class where you are attending classes as a student and a teacher is engaging class from a distant location, may be from a different country. Is this possible? Yes it is! Through e-Learning you can overcome many limitations of conventional teaching-learning process. The use of electronic media and ICT (Information and Communication Technologies) in education is termed **e-Learning**.

A. e-Learning tools

There are many tools for enhancing e-learning process. Some of thee-Learning tools are discussed below:

i. Electronic books reader (e-Books)

Think of going to school without bags packed with text books, but all necessary books are still with you in a small hand-held storage device! It is interesting, isn't it? e-Book reader is a device that can store lot of books in digital form. Portable computer devices that are loaded with digital book content via communication interfaces is called **electronic books reader**. It can open any book, any page quickly, without much effort. In principle, any web document can be downloaded from the Internet, sometimes by making online payment, and read whenever required. In some e-Book readers voice output is also available and the reader needs to just listen the audio of the text.

ii. e-Text

Textual information available in electronic format is called **e-Text**. This text can be read and interacted with an electronic device like computer, e-Book reader, etc. e• Text can be converted to various formats to our liking using softwares. e-Text can be automatically read aloud with the help of a computer or an e-Text reader device. This is quite helpful for visually challenged people.

iii. Online chat

It is a real-time exchange of text messages between two or more persons over the Internet. In the virtual class environment, online chatting is used to discuss the topics with teachers and other students. Chatting can be performed even with a low speed Internet connection. Video chatting facility is also available. It however requires fairly high speed Internet connection and supporting devices such as web camera and speakers.

On line chat is a framework that provides interaction in a social environment. It helps communicating with people at different places. This facility can also be used

to deliver and transfer live lectures given by the faculty. Students can login from the remote locations and attend the lecture.

iv. e-Content

Nowadays lot of e-Learning materials are delivered in different multimedia formats like videos, presentations, graphics, animations, etc. The e-Contents once prepared can be broadcasted through television channels, webcasted or uploaded in websites. Uploaded content can be downloaded, viewed and saved for future reference. The multimedia contents have more scope to convey the subject matter effectively. It can show actual or simulated activities which are not possible in the traditional classroom based teaching.

v. Educational TV channels

There are many telecasting/webcasting channels which are dedicated for thee• Learning purpose. These channels broadcast recorded classes on various subjects, interviews with experts, lab experiments, etc. Some of these channels can be watched in the Internet also. Dooradarshan's 'VYAS' and Kerala Government's 'VICTERS' channel are examples of educational television channels.

B. Advantages of e-Learning

e-Learning has lot of advantages. They are listed below:

- e-Learning has the ability to offer courses on variety of subjects to large number of students from distant location.
- In e-Learning cost for learning is much less. It saves journey time and money, instructor fees, etc.
- People with limited financial resources are very much supported by the lower cost of e-Learning.
- It provides facility to do online courses from various nationally or internationally reputed institutions.
- Time and place is not a constraint fore-Learning.

C. Challenges toe-Learning

Listed below are some of the challenges faced bye-Learning:

- Face to face contact between students and teachers is not possible.
- Proper interaction among teachers and students are often limited due to the lack of infrastructural facilities.
- Equipment and technology (computer and high speed Internet) requirement restrict adoption of e-Learning

- Learners who require constant motivation may not be serviced adequately.
- Hands-on practicals in real laboratory scenario is also a constraint in e-Learning.

D. Useful e-Learning websites

The summary of useful e-Learning websites are shown in Table 12.3. Figure 12.6 shows the home page ofIGNOU (Indira Gandhi National Open University).

Address of website	Purpose/Service
www.ignouonline.ac.in	Website of Indira Gandhi National Open University, one of the leading open universities offering various courses in the distance education mode.
www.nptel.iitm.ac.in	National Programme on Technology Enhanced Learning (NPTEL) provides e-Content through online Web and Video for courses in Engineering, Science and humanities streams.
www.ncert.nic.in	Website of National Council of Educational Research and Training. Includes many features such as providing study materials and reference materials in Hindi and English.
www.spoken_tutorial.org	It is an IIT Mumbai initiative. It provides software training through the spoken tutorials. All the courses are offerred totally free of cost as it is funded by the Government of India.
www.w3schools.com	W3Schools is a web developer information website, with tutorials and references relating to web development topics such as HTML, CSS, JavaScript, PHP, SQL, and]Query.
www.gcflearnfree.org	GCFLearnFree.org is supported by the Goodwill Community Foundation. It provides easy-to-follow lessons in mathematics, science and technology and English to help anyone anywhere learn skills and gain knowledge.

Table 12.3: Some e-Learning websites

Fig. 12.6: The home page of IGNOU site

www.ignouonline.ac.in

IGNOU (Indira Gandhi National Open University) is an open university under Government of India. The website provides several features including eGyankosh, which is a digital repository available in text and video format. The site also provides webcasting facility linking to education channels– Gyandarshan, Gyanvani and EDUSAT. Virtual class provides links to all the online programmes conducted by the University.

Fig. 12.7: The home page of NPTEL site

400 1

www. nptel. iitm. ac. in

NPTEL is an abbreviation for National Programme on Technology Enhanced Learning which is an initiative by seven Indian Institutes of Technology (IIT) and Indian Institute of Science (IISc) for creating course content in engineering and science. Web based Course materials have been developed for different courses and are accessible freely through the website. Lecture contents are also made available " web site through video.

Know your progress

1. Real-time exchange of text messages between two or more persons over Internet is termed _____
2. Pick the odd one out:
   a. e-Book reader b.e-Text c. television channels d. e-business
3. Define e-Text.
4. Give an example for an e-Learning tool.

12.2 Information security

Today, almost all activities that we perform in real life like, communication, buying goods, banking, etc. can be achieved through the Internet. While executing all these activities, information is exchanged between computers. The security of information passed over Internet is a primary concern. In this section, we will discuss in detail about the cyber world and the various issues like copyright and trademark violations, cyber crimes, etc. that we come across while surfing the Internet.

12.2.1 Intellectual Property Right (IPR)

Many people are engaged in creative work like music, literary work, artistic work, discoveries, inventions, designs and software development. These works are the creation of the mind. They demand a lot of hard work and time. The outcome of such work is called intellectual property. It is unjust to use the idea of a person without his permission. The person involved in developing such properties must get the benefits of it. So it should be protected from unauthorised access.

The importance of intellectual property was first recognised in the Paris Convention for the Protection of Industrial Property in 1883 and the Berne Convention for the Protection of Literary and Artistic Work in 1886. Both treaties are now administered by the World Intellectual Property Organization (WIPO). WIPO was established in 1960 as an agency of United Nations (UN). It is dedicated to ensure that the rights of creators or owners of intellectual property are protected worldwide and the

inventors and authors are recognised and rewarded by their creation. The logo of WIPO and its Indian counterparts is given in Figure 12.8.

Intellectual property rights are similar to any other property right like right over land, house, etc. **IPR** refers to the exclusive right given to a person over the creation of his/her mind for a period of time. **IPR** enables people to earn recognition and financial benefit from what they invent or create. **IPR** owners can disclose their creations in exchange for money. The company which receives the rights, markets and sells this innovation to the society. In this way, the IPR owner, the company and the society benefit from the creation. IPR is encouraged by UN and almost all countries worldwide with the intention of encouraging innovations.

Fig. 12.8: Logos of WIPO

Each country has its own IPR registration system which is applicable to that country. WIPO serves as an international registration system for trademark, industrial design, etc. which is applicable to its member countries.

Intellectual property is divided into two categories - industrial property and copyright.

A. Industrial property

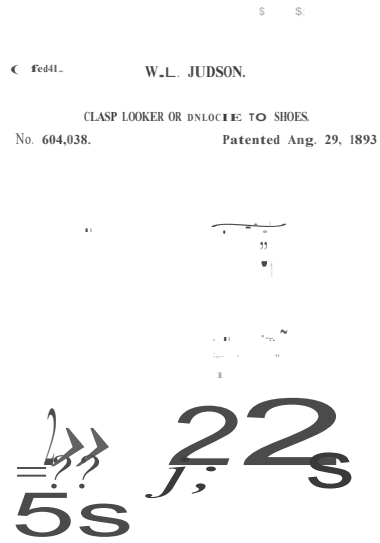
Fig. 12.9: Logo of IP India

Industrial property right applies to industry, commerce and agricultural products. It protects patents to inventions, trademarks, industrial designs and geographical indications. In India, industrial property rights can be registered with Controller General of Patents Designs and Trademarks under Ministry of Commerce and Industry. Logo of Intellectual Property India is given in Figure 12.9.

Patents: A patent is the exclusive rights granted for an invention. An invention means a new product or process (procedure) involving an inventive step, and capable of industrial application. It is the legal right obtained by an inventor for exclusive control over the production and sale of his/her mechanical or scientific invention for a limited period of time. To be patentable, an invention must:

- relate to a process or product
- benew
- involve an inventive step
- be capable of industrial use
- not be developed with the intention to harm others

Patent protection means that the invention cannot be commercially made, used, distributed or sold without the patent owner's consent. A patent provides the right to the patent owner to decide how the invention can be used by others. The owner can sell the right to the invention to someone else, who will then become the new owner of the patent. The term of every patent in India is 20 years from the date of filing of patent application. Once a patent expires, the protection ends and an invention can be used by the public freely. The details of the first patent filed for a zipper are given in Figure 12.10.


W.L. JUDSON.

CLASP LOOKER OR UNLOCKER TO SHOES.

No. 604,038. Patented Aug. 29, 1893

Fig. 12.10: The first patent for zipper

Trademark: A trademark is a distinctive sign that identifies certain goods or services produced or provided by an individual or a company. A trademark can be a name, logo, symbol, etc. that can be used to recognise a product or service. It provides protection to the owner of the trademark by ensuring the exclusive right to use it to identify goods or services. It helps consumers to identify and purchase a product or service. A trademark must be registered. The initial term of registration is for 10 years. Thereafter it can be renewed. In order to determine whether any person or company is using a particular trademark, a trademark search can be conducted through the trademark registry maintained by Controller General of Patents Designs and Trademarks (http://ipindiaonline.gov.in). The effect of a trademark registration is limited to that country. Some popular trademarks in India are given in Figure 12.11.

Fig. 12.11: Popular Indian trademarks

Industrial designs: An industrial design refers to the ornamental or aesthetic aspects of an article. A design may consist of three-dimensional features such as the shape, surface of an article or two-dimensional features, such as patterns, lines or colour. An industrial design right protects the visual design of objects that are not purely functional. Industrial designs are applied to a wide variety of industrial products and handicrafts like medical instruments, watches, jewellery, vehicles,

iPhone design

Coca-Cola bottle

textile designs, etc. The registered designs of Coca-Cola bottle and iPhone are given in Figure 12.12.

Fig. 12.12: Popular industrial designs

Geographical indications: Geographical indications are signs used on goods that have a specific geographical origin and possess qualities or a reputation that are due to that place of origin. Agricultural products typically have qualities that derive from their place of production and are influenced by factors like climate and soil. Place of origin may be a village or town, a region or a country. Some of the popular products with geographical indications related to Kerala are Aranmula Kannadi and Palakkadan Matta Rice (Figure 12.13).

Fig. 12.13: Geographical indications related to Kerala

B. Copyright

A copyright is a legal right given to the creators for an original work, usually for a limited period of time. Copyright applies to a wide range of creative, intellectual or artistic forms of works which include books, music, painting, sculpture, films, advertisement and computer software. This covers rights for reproduction, communication to the public, adaptation and translation of the work.

In India, the Copyright Act, 1957 came into effect from January 1958. This Act has been amended five times. Some of the important amendments to the Copyright Act in 2012 are extension of copyright protection in the digital environment, liabilities of Internet Service Providers, ensuring right to receive royalties for music composers and exception of copyrights for physically disabled to access any work.

Under Indian Copyright Act, a work is automatically protected by copyright when it is created. The general rule is that the copyright lasts for 60 years after the death of the last surviving author. Registration of copyright gives a legal status to a creative work. This makes it an intellectual property, giving exclusive legal right over the creation. It should be noted that it is not necessary to register to get the copyright. Copyright registrations in India are handled by the Copyright Office under the Ministry of Human Resource Development. The logo of Indian Copyright Office is given in Figure 12.14.

Fig. 12.14: Logo of Copyright Office, India

Table 12.4 shows the different symbols used to specify the registration status of intellectual property.

The copyright holders of a work can authorise or prohibit

- its reproduction in all forms, including print form and sound recording;
- its public performance and communication to the public;

- its broadcasting;
- its translation into other languages;
- its adaptation, such as from a novel to a screenplay for a film.

INTELLECTUAL PROPERTY	
Registered trademark	®
Unregistered trademark	TM
Copyright	C
Sound-recording copyright	!

Table 12.4: Symbols used for intellectual property

Creators often sell the rights of their works to individuals or companies for financial benefit.

Computer software (source code, databases, web sites, etc.) can be copyrighted as a literary work. Even though computer software is protected under copyright, nowadays they are increasingly getting patented. This is because software development is considered as an industry and patents provide better protection when compared to copyright. It should be noted that the criteria required for obtaining patent protection is more stringent.

Table 12.5 displays the rights and the related intellectual property. The differences in the registration of rights of intellectual property are shown in Table 12.6.

Intellect	Property	Right
Idea	Invention/innovation	t
Idea	Quality + identity	ark
Idea	Appearance	Design
Goods	Geographical origin	Geographical Indication
Idea	Expression	Copyright

Table 12.5: Rights related to intellectual property

	Patent	Trademark	Copyright
Refers to	Product, Process	Name, Logo, Symbols	Creative, intellectual or artistic forms of work
Registration	Required	Required	Automatic, can be registered
Duration	20 years	10 years	Until 60 years after the death of the last surviving author
Renewable	No	Yes	

Table 12.6: Differences in the registration of rights for intellectual property

"""":::a:::

12.2.2 Infringement

Unauthorised use of intellectual property rights such as patents, copyrights and trademarks are called intellectual property infringement. It may be a violation of civil law or criminal law, depending on the type of intellectual property, jurisdiction (countries) and the nature of the action.

Patent infringement is caused by using or selling a patented invention without permission from the patent holder. Many countries allow using patented inventions for research purpose. The legal dispute between Apple and Samsung over their mobile phone technologies is an example of patent infringement.

Trademark infringement occurs when one party uses a trademark that is identical to a trademark owned by another party, where both the parties use it for similar products or services. It is better to register the trademarks to get the legal advantages. An example of trademark infringement is the legal suit where a small company manufactured toffees under the trademark 'HORLIKS'. This violated the trademark rights enjoyed by 'HORLICKS'.

Copyright infringement is reproducing, distributing, displaying or adaptating a work without permission from the copyright holder. It is often called piracy. Software piracy is the illegal copying, distribution, or use of software. Music piracy is the copying and distributing of a piece of music without the consent of the composer, artist or the copyright holding music company. Enforcement of copyright is generally the responsibility of the copyright holder.

Know your progress

1. Creation of the mind is known as _____.
2. Expand WIPO.
3. Intellectual property rights are categorised into _____ and _____.
4. Patents are exclusive rights given to _____.
5. _____ Is a sign used to recognise a product or service.
6. What is industrial design?
7. What is the importance of geographical indicators?

12.2.3 Cyber space

Cyberspace is a virtual environment created by computer systems connected to the Internet. It is the term used to refer to a simulated world, where we can do many things at one place. Let us now discuss various instances where cyberspace has influenced our lives.

Formerly, communication was mainly dependent on postal service. Now a days e• mail has gained wide acceptance and legal validity for communication. In the Department of Higher Secondary Education (DHSE), all communications to higher secondary schools related to admissions, examinations, National Service Scheme, administration, etc. are done through *website/e-mail* Today, Internet has become a popular medium for communication among common people.

In December 2012, a girl student was subjected to inhuman physical torture in a moving bus in a metro city in India. After a few days the girl succumbed to her injuries. This incident invoked protests among people from various walks of life. Social media like facebook, twitter, etc. became a platform for the protest. These people organised a movement in support of the girl through messages over the social media. Thousands of people gathered in the streets of Delhi with lighted candles as a protest. Taking this incident into account, the Loksabha passed 'The Criminal Law (Amendment) Act, 2013', which strictly deals with sexual assault cases. Such movements organised over *social media,* show its influence on society.

People purchase mobile phones, shoes, apparels, etc. by visiting showrooms. Today, many people prefer to purchase these goods online from e-commerce websites. The *e-commerce* sites provide catalogs which display different search options like price range, brands, etc. about the product. This made shopping easier from the comfort of home and saves time too. E-commerce requires payments through credit cards, debit cards, Internet banking, etc. Nowadays more and more people are attracted to online buying and selling. Figure 12.15 shows e-commerce websites.

Fig. 12.15 : Sample e-Commerce websites

Almost all banks offer *Internet banking* facilities to its customers. Through this facility we can transfer funds, pay telephone bills, electricity bills, payments for online purchases, train tickets, cinema tickets, etc. This saves a lot of time and effort when compared to performing these activities by actually visiting the respective offices. Hence banking is also a popular service over Internet. An Internet banking website is displayed in Figure 12.16.

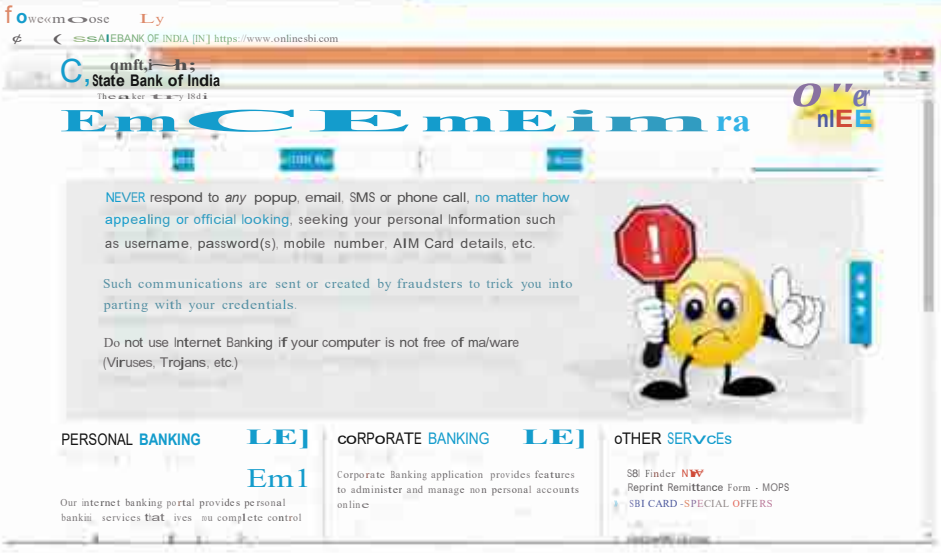


Fig. 12.16: An Internet banking website

With the passage of time, more services are going online. Many people spend a considerable amount of time surfing the Internet to avail of various services in the web. Internet is often referred to as cyberspace. Figure 12.17 shows a symbolic representation of cyberspace.

Fig. 12.17 : Symbolic representation of cyberspace

Cyberspace is an unreal world in which communication over computer networks occurs. It is an information superhighway where individuals gather information, interact, exchange ideas, provide social support, conduct business, play games, engage in discussions and so on.

Cyberspace is a space where social interactions dominate. Some people consider cyberspace as an uncontrolled and unregulated electronic space where anyone is free to do anything as they wish and express themselves freely. Such acts of people affect or negatively influence many others. Hence, when an individual works on the Internet, they have to follow some rules and ethics which are beneficial to all users.

This unregulated space also provides room for criminals. Since activities like communication, financial transactions, etc. in the cyberspace increase day by day, it has opened a new medium for criminal activities. Today cyberspace security has become a serious concern.

'Cyberspace' is a term coined by William Gibson, a Canadian science fiction writer, in his short story 'Burning Chrome' (1982). He used it to represent a world where events or transactions occur that are not in real world. He believed that cyberspace is a consensual hallucination. According to Gibson, consensual hallucination is the nature of existence within cyberspace.

12.2.4 Cyber Crimes

We know that the Internet has opened new opportunities in entertainment, business, communication education, sports, etc. At the same time, it is a reality that some people use the Internet for committing illegal activities.

The increasing use of the Internet through smart phones and tablets for online banking and other financial transactions has increased the risk. Rising Internet penetration and online banking provides opportunities for cyber criminals to target online financial transactions, using malicious software (malware) or through illegal hacking.

The statistics of cyber crime committed in the recent years according to National Crime Records Bureau is given in the graph shown in Figure 12.18. This graph shows the significant rise of cyber crimes in India through the years.

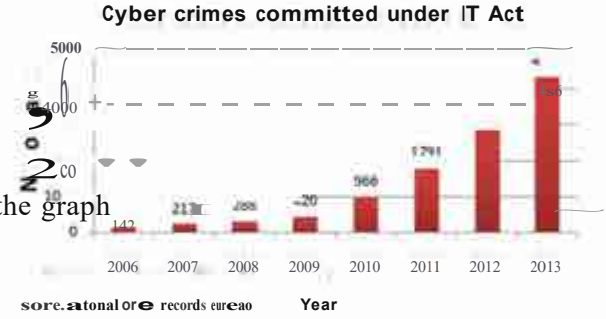


Fig. 12.18: Cyber crime statistics in India

Cyber Crime is defined as a criminal activity in which computers or computer networks are used as a tool, target or a place of criminal activity. The victims of cyber crime lose money, reputation and face mental trauma.

An important aspect of cybercrime is its nonlocal character. A crime can occur in jurisdictions separated by vast distances. That is an attacker may operate from a country and attack a destination in some other country. So the investigating team and the judiciary of different countries must keep hand in hand. Due to the anonymous nature of the Internet, it is possible for people to engage in a variety of criminal activities. People commit cyber crimes knowingly or unknowingly.

Cyber crimes include phishing, hacking, denial of service attacks, etc. which we have learned in Chapter 12 of Class XI. Computer crime mainly consists of unauthorised access to computer systems, credit card frauds, illegal downloading, child pornography, cyber terrorism, creation and/or distribution of viruses, spam and so on.

"""":::a:::

Cyber crimes can be basically divided into 3 major categories: They are cyber crimes against individuals, against property and against government.

A. Cyber crimes against individuals

The popularity of broadband Internet increased the dependence of Internet for daily activities. This increased the risk of online crimes. An act of a person in cyberspace that causes physical or mental trouble to an individual is referred to as cyber crime. Harassment, assuming someones identity, impersonation and violation of privacy are some examples of cyber crimes.

i. Identity theft: Identity theft occurs when someone uses another person's identifying information, like their name, credit card number, etc. without their permission to commit fraud or other crimes. It is a form of stealing a person's identity, by which someone pretends to be someone else, to gain access to resources like bank account, social media accounts, etc. This is done with the intention of transferring money from the victim's bank account, payments for purchases, defaming the person through social media, etc. This is done with the intention of obtaining credit from financial institutions or gaining benefits in that persons name.

Before transferring money from bank accounts, the thief may change the mailing address of the account so that the victim will not be able to realize that money is withdrawn. The stolen personal information may be used to open new accounts, open new credit card accounts, to apply for a mobile phone connection and more.

ii. Harassment: Posting humiliating comments focusing on gender, race, religion, nationality at specific individuals in chat rooms, social media, e-mail, etc. is harassment. The use of vulgar or indecent language, threatening any illegal or immoral act through a computer or a computer network is considered as harassment.

The use of the Internet, to harass someone is called cyber stalking. You might have read about statements from celebrities that the facebook accounts in their names are fake. This is because such accounts may contain pictures or posts with defaming content. These profiles might be created using the photographs and personal information of the celebrity by people with criminal intentions. There are people who defame others by sending humili ating e-mails, facebook posts, etc. All these amount to harassment. Common characteristics of cyber stalking include threats, false accusations, monitoring, identity theft and data destruction or manipulation. Cyber

stalking also includes sexual or other exploitation of minors. It can destroy friendships, careers, self-image and confidence.

iii. Impersonation and cheating: Impersonation is an act of pretending to be another person for the purpose of harming the victim. There are people who utilise the anonymity of the Internet to commit impersonation online.

Sometimes we may receive e-mails seeking help for transferring large amounts of money from a distant country to India. Usually, the sender states that this money is in the form of an asset (land, gold, etc.) that is to be sold. To dispose the asset and complete the legal formalities, the sender requires some amount of money. The mail requests us to share a portion of the expenses and offers us up to 50% of the value of the asset. After receiving the cheque or money order, the sender tells that due to some complications more money is required. In this way the victim may lose large amounts. We often receive similar mails with a different story. Mailing scams like this are examples of Internet fraud/cheating.

Similar crimes occur in online auction also. In some cases, individuals announce products for sale on Internet auction sites. They demand money before the delivery of the item and never carry out their order.

iv. Violation of privacy: Violation of privacy is the intrusion into the personal life of another, without a valid reason. This gives the person whose privacy has been invaded, the right to file a lawsuit for damages against the person/organisation that intruded. It consists of distributing private information like personal data, photography, workplace monitoring videos, etc.

You might have heard of issues regarding the use of hidden cameras, mobile cameras, etc. to capture images of women in public places. Photography of any person (men or women) without his/her permission amounts to violation of privacy. Posting images of others in social media, transferring them to others through e-mail/copying, etc. without their permission are considered as violation of privacy.

v. Dissemination of obscene material: The Internet has provided a medium for the facilitation of crimes like pornography. The distribution and posting of obscene material is one of the important cyber crimes today. Pornography on Internet may take various forms. It may include hosting website containing prohibited materials, use of computers for producing obscene material, downloading obscene materials through the Internet, etc. These obscene content may misguide adolescents.

Most of the cyber crimes occur without the knowledge of the victim, whereas in some others, the victim also takes part in crime to become rich easily. It should be noted that various types of preventive mechanisms have been installed to avoid such crimes.

E-mail service providers use spam filter that filters unwanted mails. Different types of authentication mechanisms that exist for online financial transactions prevent fraud to a certain extent. Above all, an individual has to be careful while using Internet.

B. Cyber crimes against property

Cyber crimes against all forms of property like credit cards, intellectual property, etc. are termed as cyber crime against property. These crimes include hacking, piracy, computer vandalism (destruction of others property), unauthorised intrusion through cyberspace, unauthorised possession of information stored in computers, etc. Some classifications of cyber crimes against property are given below.

i. Credit card fraud: Credit card fraud involves an unauthorised usage of another person's credit card information for the purpose of payments for purchases or transferring funds from it. There are instances where the web servers of large organisations are hacked and credit card information of a large number of people is stolen by Internet thieves. They use this information to make payments or they sell this information to other fraudsters over Internet for a small price.

ii. Intellectual property theft: The infringement of IPRs come under this category. Violation of copyright, patent, trademark, etc. are intrusions against property.

Recently an Indian IT company developed a software for correcting errors in program code. One of the employees of this company copied this software in a CD and tried to sell it to a competitor for a big price. This led to huge financial and property loss to the company. This is considered as theft of intellectual property. Software piracy is also a crime under cyber law.

Nowadays intellectual property theft has become common. Information about any topic is now freely available on the Internet. Copying of another person's language, thoughts, ideas or expressions and presenting them as one's own original work is called plagiarism. There are stringent copyright laws available in India which protect the intellectual property rights. Plagiarism can be easily detected through various tools available online.

iii. Internet time theft: Today almost all modems/routers have wireless Internet facility. They provide sharing of Internet at homes, schools, business establishments, etc. If this is not properly secured using passwords, other people may use our Internet. The usage of the Internet time by unauthorised persons, without the permission of the person who pays for it is called Internet time theft. This leads to loss of Internet

time and money. Above this, others may use our Internet account for committing crimes, for which we may also be held responsible.

The different types of attacks like viruses, worms, man in the middle attack, etc., discussed in Chapter 12 of Class XI also fall under cyber crimes against property.

C. Cyber crimes against government

Increasing popularity of e-governance has made governments vulnerable to cyber attacks. The various governmental computer networks and websites are vulnerable to risks and threats of cyber crimes. The different categories of cyber attacks against government are cyber terrorism, website defacement and e-governance denial attack.

i. Cyber terrorism: Cyber terrorism is a cyber attack against sensitive computer networks like nuclear power plants, air traffic controls, gas line controls, telecom, etc. These types of attacks against governments are increasing globally. Cyber terrorism focuses on the use of the Internet by anti nationals to affect a nation's economic and technological infrastructure.

In 2010 a computer virus called tuxnet was used to carry out an invisible attack on Iran's secret nuclear programme. This virus was aimed at disabling Iran's Uranium enrichment programme. This virus infected a large number of nuclear controls and gave false instructions leading to nuclear malfunctions and break down.

Cyber terrorism may prove to be very costly to a country. Therefore governments provide very powerful security mechanisms for their servers.

ii. Website defacement: This is a common cyber attack against a government. Defacement of websites includes hacking of government websites and posting derogatory comments about a government in those websites.

iii. Attacks against e-govemance websites: These types of attacks deny a particular online government service. This is done using a Distributed Denial of Service (DDoS) attack which we discussed in Chapter 12 of Class XI. In another case the website may be hacked and controlled by the hackers. They gain access to website administration through content management system and destroy the data. This causes huge loss to the government.

Cyber terrorism has increased in the modern world because of the anonymous nature of cyberspace. The availability of a variety of targets that affect a large number of people, and the fact that attacks can be conducted from a distance have increased terrorism through cyberspace.

12.2.5 Cyber ethics

The available statistics shows that the volume of cyber crimes is increasing rapidly all over the world. Internet crime has many faces and is committed in diverse ways. Awareness is the first step in protecting ourselves, our family and our business. We should ensure that our actions in the cyberspace do not harm others. We should also remember that our actions over the Internet are being monitored by several others.

Suggestions given below can be considered as ethical practices over the Internet.

- Use anti-virus, firewall, and spam blocking software for your PC.
- Ensure security of websites (https and padlock) while conducting online cash transactions.
- Do not respond or act on e-mails sent from unknown sources.
- Use unique and complex passwords for accounts and change your passwords on a regular basis. (Should have a minimum of 8 characters, contain alphabets, numbers and special characters)
- Do not select the check boxes or click OK button before reading the contents of any agreement/message.
- Avoid the use of unauthorised software.
- Do not hide your identity and fool others.
- Do not use bad or rude language in social media and e-mails.
- Remove the check mark against 'Remember me' before logging into your account using computers other than your personal ones.

Let us do

Conduct an awareness program about various cyber crimes.
Prepare a chart listing how we can protect ourselves in cyber space.

Know your progress

1. What do you mean by cyberspace?
2. Criminal activity using computer, mobile phone and Internet is termed as _____.
3. What is cyber crime against a person?
4. Cyber terrorism is a type of cyber crime against _____.
5. Stealing one's information such as username and password is _____.

12.2.6 Cyber laws

The term cyber law in general refers to the legal and regulatory aspects of the Internet. Cyber law can be defined as a law governing the use of computers and Internet.

We have already discussed that there are different kinds of cyber crimes. Criminal activities such as theft, fraud, forgery and defamation are traditional in nature and are subject to the Indian Penal Code. The abuse of computers (cyber crime) has become wide spread in India which is addressed by the Information Technology Act, 2000 and IT Act Amendment Bill 2008.

Cyber law is important because it touches almost all aspects of transactions and activities using Internet. Whether we realise it or not, every action and every reaction in cyberspace has some legal perspectives.

12.2.7 Information Technology Act 2000 (Amended in 2008)

The Information Technology Act, 2000 is India's legislation regulating the use of computer, servers, computer networks, data and information in electronic format. The legislation has touched various aspects related to authentication, digital signature, cyber crime and liability of network service provider. The acts aim to provide legal recognition for transactions carried out by means of electronic data interchange and other means of electronic communication. IT Act allows using alternatives to paper based communication and facilitates electronic filing of documents with government agencies. It gives legal acceptance for electronic communication. It also addresses offenses and disputes in the cyberspace and provides justice to victims of cyber crimes.

IT Act aims to provide legal infrastructure for e-commerce in India. This Act was developed to promote IT industry, regulate e-commerce, facilitate e-governance and prevent cyber crimes. It promotes security practices within India that would serve the country in a global context. Under the Act certain violations are treated as serious crimes and offenders are liable to penal actions. Therefore it is important to understand the various perspectives of the IT Act, 2000 and what it offers.

In May 2000, the Indian Parliament passed the Information Technology Bill and it is known as the Information Technology Act, 2000. The Act was amended by the Information Technology Amendment Bill 2008, which was passed in December 2008. This amendment accommodates further development of IT and related security concerns, since IT Act 2000 was passed. Compensation has to be given to affected persons if damage is done to the computer system or computer network by the introduction of virus, denial of service, etc. Sections 65–74 of the Act specifically deals with cyber crimes.

SOME **COMMON** OFFENCES AND THEIR PUNISHMENTS NOTED IN **IT** ACT 2000 AND **IT** AMENDMENT 2008

Section	Offences	Punishments
65	Tampering with computer source code	Imprisonment up to three years, or with fine which may extend up to two lakh rupees, or with both.
66	Computer related offences	Imprisonment for a term which may extend to two three years or with fine which may extend to five lakh rupees or with both.
66B	Punishment for dishonestly receiving stolen computer resource or communication device.	Imprisonment for a term which may extend to three years or with fine which may extend to rupees one lakh or with both.
66C	Punishment for identity theft.	Imprisonment for a term which may extend to three years and shall also be liable to fine which may extend to rupees one lakh.
66D	Punishment for cheating by personation by using computer resource.	Imprisonment for a term which may extend to three years and shall also be liable to fine which may extend to one lakh rupees.
66E	Punishment for violation of privacy.	Imprisonment which may extend to three years or with fine not exceeding two lakh rupees, or with both.
66F	Punishment for cyber terrorism.	Imprisonment which may extend to imprisonment for life.
67	Punishment for publishing or transmitting obscene material in electronic form.	Imprisonment for a term which may extend to two to three years and with fine which may extend to five lakh rupees. In the event of a second or subsequent conviction with imprisonment for a term which may extend to five years and also with fine which may extend to ten lakh rupees.
67A	Punishment for publishing or transmitting of material containing sexually explicit act, etc. in electronic form.	Imprisonment for a term which may extend to five years and with fine which may extend to ten lakh rupees.

Section	Offences	Punishments
67B	Punishment for publishing or transmitting of material depicting children in sexually explicit act, etc. in electronic form.	Imprisonment for a term which may extend to five years and with a fine which may extend to ten lakh rupees. In the event of second or subsequent conviction with imprisonment for a term which may extend to seven years and also with fine which may extend to ten lakh rupees.
Punishment for sending offensive messages through online communication services like e-mail, social media, SMS, etc. will be according to the sections in Indian Penal Code (IPC).		

12.2.8 Cyber Forensics

The increase in computer crimes affects our daily lives and national security. Internet and digital technologies bring us a lot of convenience. But at the same time they also provide criminals more chance to commit crimes. Traditional law enforcement tools and methodologies do not successfully address the detection, investigation and prosecution of cyber crime.

Forensics is the process of using scientific knowledge for identifying, collecting, preserving, analyzing and presenting evidence to the courts. Cyber forensics can be defined as the discipline that combines elements of law and computer science to collect and analyze data from computer systems, networks, communication systems and storage devices in a way that is admissible as evidence in a court of law. The goal of computer forensics is to analyse data in a way that preserves the integrity of the evidence collected so that it can be used effectively in a legal case.

12.2.9 Infomania

Information is considered as the key to success. It has to be collected, managed and processed well. But what happens if a person gets overloaded with information? Infomania is the state of getting exhausted with excess information. It occurs due to accumulation of information from many sources like Internet, e-mail and cell phones, but cannot be processed. While collecting information, its quality and relevance are also to be considered. Infomania is the excessive enthusiasm for acquiring knowledge. This may result in neglecting the more important things like duties, family, etc. We may see people browsing for information during dinner. It is now treated as a psychological problem. Constantly checking e-mails, social networking sites, online news, etc. are the symptoms of infomania. Many people do this to keep themselves up to date with the fear of being out of the group.

Studies prove that people addicted to infomania lose concentration and sleep. Excessive use of technology reduces intelligence. Some people give high priority to respond to incoming messages through mail and social media. These people may skip or interrupt their important family or professional engagements to answer an e-mail or a social media post.

To get away from such situations, users must learn to log off social media, online news and discussion groups while they are at work or spending time with family.

Know your progress

1. The year in which IT Act came into existence in India is _____.
2. What is the purpose of IT Act?
3. What do you mean by cyber forensics?
4. _____ is the excessive enthusiasm for acquiring knowledge.

Let us conclude

Information Technology is a fast growing field. It is widely used in our day today activities. Business transactions, government activities, learning processes, etc. are some of the major areas where IT is substantially utilised. The advancements in the development of communication owes much to information technology. ICT is another term often used as an extended synonym for IT. Hence IT and ICT enabled services have become inseparable part of modern society. In the techno savvy world of 21st century, more people are engaged in Internet through social networks, net• banking, mobile applications, e-shopping, etc. It is a reality that Internet has made life easier. A person can do a variety of jobs through cyberspace. Due to its anonymous nature, cyber space has became a venue for criminals. Crimes can be against a person, property or government. The best way to be safe is to be aware of the traps in the Internet. The rights of creator or owner of music, software, artistic works, inventions, etc. are protected by Intellectual Property Rights. There are cyber laws which provide the framework for a secure environment in cyberspace. India has a robust IT Act. It addresses the different crimes committed using computers, Internet and mobile phones. Cyber forensics has emerged as a part of legal proceedings of almost all civil and criminal cases. Any crime committed using IT infrastructure leaves a digital evidence that makes it easily detectable. While using the Internet, ensure that our actions do not harm others. The term infomania is used for addressing the problems created by information overloading.

Let us assess

1. Name an electronic device used to read e-Text.
2. Name any two e-Learning tools.
3. List out different types of interactions in e-Governance.
4. What are the advantages of e-Governance?
5. What are the duties of Akshaya?
6. What are the major challenges faced in the implementation of e-Learning?
7. Compare the advantages and disadvantages of implementing e-Business?
8. What is cyberspace?
9. Why is cyberspace called a virtual world?
10. Phishing is an example for _____.
11. Explain different categories of cyber crimes in detail.
12. "Awareness is the best way to protect ourselves in cyberspace". Comment.
13. How do trademark and industrial design differ?
14. What is copyright? How does it differ from patent?
15. Explain the exclusive right given to the owner by **IPR?**
16. What is piracy?
17. What do you meant by infringement?
18. Why is a cyber law important?
19. "Non-local nature of cyber crime creates problems to the investigators". Explain.
20. "Infomania has become a psychological problem". Write your opinion.

be References

Stroustrup, B. (2013). *The C++ Programming Language.* New Delhi: Addison-Wesley Professional

Lafore, R. (2009). *Object-Oriented Programming in C++.* Chennai : Sams Publishing

Balagurusamy, E. (2008). *Object Oriented Programming with C++.* New Delhi: Tata McGraw-Hill Education

Sharma, A.K. (2011). *Data structure using C.* New Delhi : Pearson Education India

Srivastava, S.K.& Srivastava, D. (2011). *Data Structures Through C in Depth.* New Delhi: BPB Publications

Powel, T. A. (2010). *The Complete Reference: HTML & XHTML.* New Delhi: OSborne/Tata MC Graw-Hill

Lloyd, I. (2008). *The Ultimate HTML Reference.* Melbourne: Sitepoint

Holzner, S. (2000). *HTML Black Book.* New Delhi: DreamTech Press

Frain, B. (2012). *Responsive Web Design with HTML5 and CSS3.* Mumbai: Packt Publishing

Powel, T. A. & Schenider, F. (2008). *The Complete Reference JavaScript.* New Delhi : Tata McGraw-Hill

Zakas, N. C. (2012). *Professional JavaScript for Web Developers.* Birmingham : Wrox

TM