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Advantage of Programming Languages in Computer Science

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ABSTRACT
Computer programming languages allow us to give instructions to a computer in a language the computer understands. Just as many human-based languages exist, there is an array of computer programming languages that programmers can use to communicate with a computer. Programming is a basic need to teach to computer science students. Besides these advantages, programming language serves as a fundamental tool for analyzing, studying and understanding advanced concepts of computer science that the students are taught in later semesters of their undergraduate studies. Therefore, the selection of a programming language for teaching to computer science students is extremely important. During the past years, there have been numerous programming languages evolved such as COBOL, FORTRAN, Miranda, Oberon, Ada and Java etc. With the passage of time, some these languages have lost prominence while several new languages have emerged. Therefore, the selection of a programming language for teaching has always remained an important research question for academicians. In this paper, a comparative analysis of contemporary programming languages is performed. We have selected C/C++, C#, Java, Pascal, GW Basic and JavaScript for comparison. The objective of this study is to determine which programming languages should be taught to computer science students at introductory level. The paper analyzes the selected programming languages based on different parameters and provides recommendations on the selection of programming language.

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I. INTRODUCTION

There are dozens of programming languages used in the industry today. According to various studies, students have problems in comprehending what is happening in memory, instruction cycle, and overall picture of the execution of program. As computer science is a rapidly evolving field, the answer to this question varies with the passage of time. In this paper, an updated analysis of major programming languages of recent time has been performed. The selection of the programming language is based on surveys such as of various introductory level programming courses taught at college/ undergraduate level. This paper compares C/C++, C#; Java, Pascal, GW Basic and JavaScript based on different criteria and provide recommendations. C Language is a structure-oriented, middle-level programming language mostly used to develop low-level applications. Pronounced C-sharp (not C-hashtag), C# is a multi-paradigm programming language that features strong typing, imperative, declarative, functional, generic, object-oriented and component-oriented disciplines.

II. A COMPARISON OF MAJOR PROGRAMMING LANGUAGES

This section compares the selected programming languages based on the criteria outlined above. A language should have a simple, easy to use syntax that is closer to natural language. Pascal and GW Basic have a very simple syntax. It uses self-explanatory keywords such as begin, end, to write blocks of code. JavaScript, C++, C# and Java has almost similar syntaxes that have now been widely accepted for general purpose programming language. Following compares sample Hello Word code for Pascal, GW Basic and Java

Pascal

```
Program Hello Word;
Begin Write ('Hello World.');
End.
```

GW Basic

```
10 print "Hello World"
```

Run

Java

Java is a general-purpose, object-oriented, high-level programming language with several features that make it ideal for web-based development.

```
public class Test {
public static void main(String args[]) {
System.out.println(“Hello World”);
}
}
```

Writable

The writable of a language stands for the availability of different types of constructs to easily write different types of programs. All of the languages provide basic constructs for looping, conditional statements, procedures etc. However, GW Basic, Pascal, C and JavaScript don’t provide adequate support for data types. In C, for instance, it is very difficult to operate on strings. Similarly, support for Boolean data type is not available. User defined data types can be created in C language using struct, type def, enumerations etc. In JavaScript, user defined data types can be created using objects. Java and C# provide good support for data types such as integer, long, float, double, character, Boolean and String data types.

Reliability

The availability of pointers in Pascal and C impacts its reliability as this can create dangling references. C# also allows the use of pointers but in unsafe region. An unsafe region provides the flexibility to the program to perform various restricted operations, put it puts additional burden on programmer to handle various low level issues (such as memory leakages, dangling pointers and type safety). C#, Java and JavaScript support exception handling. Following shows exception handling code for Java.

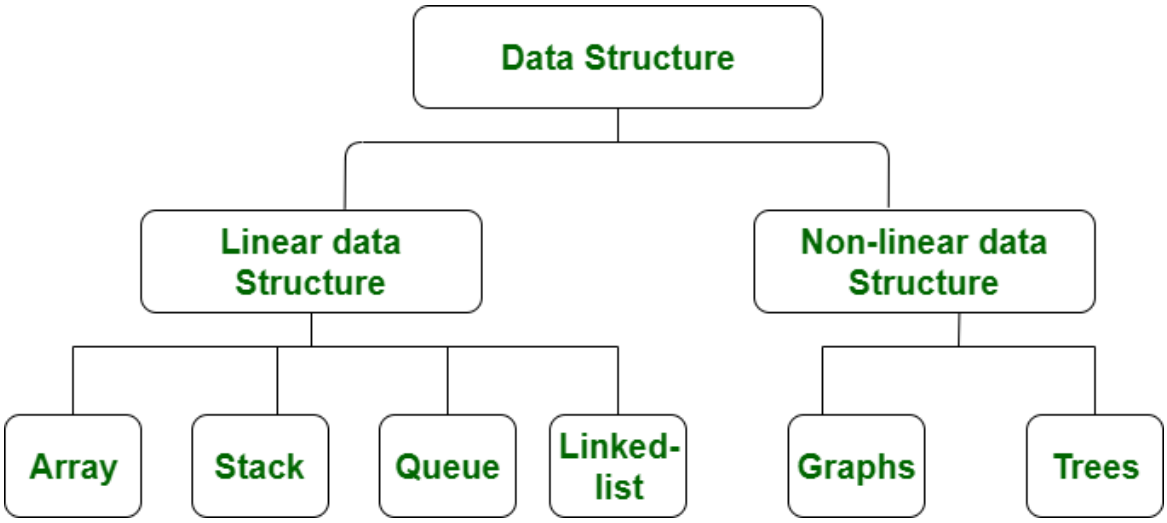
```
try
{
FileOutputStream fos = new FileOutputStream (“C:/data.txt”);
fos.write(“Sample data”);
}
catch (IOException e)
 {
System.out.println(“IO Exception occurred”);
}
try {
myFun();
}
catch (e) {
document.writeln(“Exception occurred”);
 }
```

However, JavaScript is not type safe language. The same can be said for language. C language doesn’t provide support for exception handling, however, assertions can be used. In addition, the global variable errno can be used to track the error. Following shows how error no can be used in C language. The use of go to in GW Basic also adds to unreliability in program.

```
#include “errno.h”
#include “string.h”
 int o = read(ffd, buffer, 1);
if(o == -1) {
 printf("Error! %s\n", strerror(errno));
 }
```

Data Structures

Java provides eight basic data types i.e. byte, short, int, long, char, float, double and Boolean. In addition, there is support for String and long range integers and real numbers in the form of available classes. User defined data types can be created using classes. C language has support for int, long, float, char and double, but doesn’t provide Boolean data type. String variables are manipulated using character array or character pointer where the end of the string is delimited by null character (‘\0’). User defined data types can be created using structure, type def, enumerations etc. C# provides support for various data types such as byte, short, and integer, long, single and double precision real numbers, decimal, Boolean, date, char and string.



User defined data types can be created using structure, enumeration and classes. Pascal has support for string, integer, and real, Boolean and character data types. User defined data types in Pascal can be created using enumerations, sub-ranges, records and set. GW Basic provides support for string, integer, and single precision and double precision real numbers. In JavaScript, variables are not explicitly declared to be of any type, but their types are determined based on the value they hold. A variable can hold numeric, string or Boolean value.

Community Support

The community support for each of the above language is available. Comprehensive documentation for Java is available in the form of java docs. The community support for Java is available at. Similarly support for C# is available at. JavaScript is an emerging language and support for AJAX, j-Query, Angular Js is available at different forums such as. Even though, support for Pascal, GW Basic and C language is available in the forms of books, online courses, and some forums, but their support is not comprehensive.

OS/Machine Limitations

The IDE for GW Basic, C and Pascal can easily be run with low configuration requirements such as on Pentium IV. JavaScript doesn't require any specific platform to run as it can be easily run on a browser. Java Development Kit (JDK) can be run on small configuration, however, its IDE requires Core 2 Duo machine to run. The latest version of Microsoft Visual Studio requires Windows 8 to run.

Extensions/ Library available

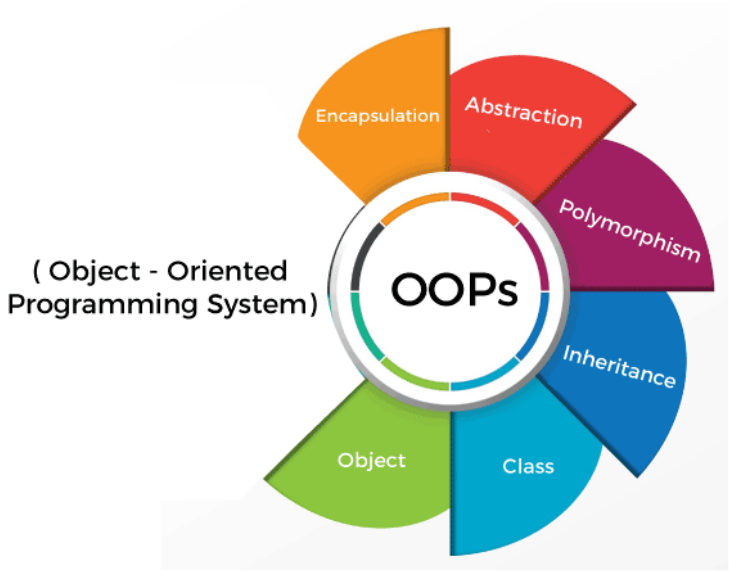
The extensions for Java and C# are easily available for general purpose task such as web programming, Bluetooth communication, hardware interfacing and Graphical User Interface (GUI). This includes Servlets, Java Server Pages (JSP), Asynchronous JavaScript and XML (AJAX) toolkit etc. JavaScript is an emerging language and a large number of extensions for it is available such as Angular-JS, Expres-Js, Socket.IO, Node-Js, D3, Fire Base and Web-GL etc. C language has been used for many years; hence, extensions for it are readily available such as OpenGL, NS2 extensions etc.

Coverage

For a primary language to be taught to students, it is essential that it extensively covers various notions such as OOP, multithreading, databases, networking and mobile computing etc. An introductory programming language once learnt by student can be used primarily for demonstrating these advanced notions of computer science. This section discusses how the major programming languages provide support for these concepts.

III. Object Oriented Programming

The languages like C, GW Basic and Pascal don't provide support for object oriented programming. C++, an extension of C language can be used for object oriented programming. Both Java and C# are 100% object oriented programming languages. It has support for implementing concepts such as encapsulation, inheritance, polymorphism, aggregation and composition. JavaScript can be regarded as an object based programming language as it has support for basic concepts of object oriented programming such as classes, association, and inheritance.



However, concepts such as encapsulation and polymorphism are not supported. Inheritance can be implemented using prototypes.

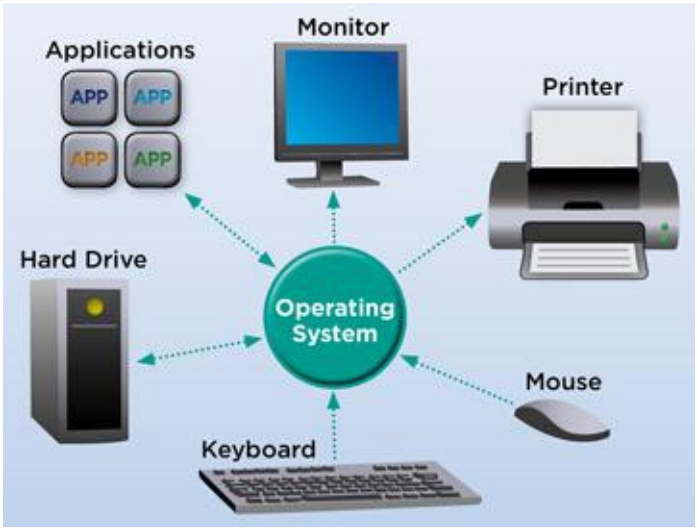
```
var student = {
id: 2, calmarks: function(b){ return marks;
} };
var graduateStudent = Object.create(student);
 p.dissertationTitle = “Data Mining”;
```

Databases

The concepts of database can be implemented in C# and Java using ADO .NET and JDBC. In addition, database connectivity can be provided for document databases such as MongoDB. JavaScript can be used to connect to any type of databases such as MySQL, SQL Server, MongoDB etc. In C language, database connection can be made using ODBC API. Interfacing with databases is a very trivial task in GW Basic and Pascal language.

Operating System

C, C# and Java provide support for implementing different operating system concepts such as multithreading, I/O, monitor, semaphores, memory management and process management.



In JavaScript, the concept of threads is slightly different. Worker threads are used to implement multithreading. Figure 6 shows the example. File I/O can be performed but in a sandboxed environment. Performing multithreading in Pascal and GW Basic is not possible.

```
var w = new Worker("thread2.js");
```

```
w.postMessage("Hello");
w.terminate();
```

Low Level Programming

In Pascal, C language low level programming task can be easily performed such as using interrupts, process management, inter-process communication, protected operating system calls etc. In C#, these operations can be performed in unsafe region. In Java, system level programming can be done using native methods. GW Basic can interface with assembly language by using USR function and CALL statement.

```
uses Dos;
procedure BORDER (color : byte);
var regs : registers;
begin FillChar (regs, SizeOf(regs), 0);
regs.ax := $0B00;
regs.bh := $00;
regs.bl := color;
Intr ($10, regs);
End
```

Network programming

Pascal, C, Java and C# provide support for network programming using Transmission Control Protocol (TCP) and User Datagram Protocol (UDP) sockets. Following shows an example of TCP sockets in Java.

JavaScript is a client-side programming language that runs inside a client browser and processes commands on a computer rather than a server. It is commonly placed into an HTML or ASP file. Despite its name, JavaScript is not related to Java. In JavaScript, socket communication can be performed using Socket. IO API. Socket programming in Pascal and GW Basic is not a trivial task.

```
Import java.net.*;
… try { Socket s = new Socket(host,port);
OutputStream os = s.getOutputStream();
os.write("Data");
os. close();
}
catch(Exception e) { System.out.println("Error");
}
```

IV.CONCLUSION

It can be concluded that Java is the best general purpose programming languages to be used for teaching computer science concepts. It has good writable, reliability, market demand and can be used to teach any computer science concept such as operating system, mobile computing etc. Besides Java, C# can also be used to teach computer programming. Languages such as Pascal and GW Basic had been used widely to teach introductory level course, but are no longer in demand in market, nor can they be used to implement modern concepts of computer science such as delegates, design patterns and object oriented programming etc. Programming Languages are the basic requirement for the development of technologies. In this paper it has discussed that what is the important role of the computer languages and how it enhance in future an analysis of major programming languages of computer science is done. The paper compares the selected languages based on different factors such as their readability, writable, support, market demand and coverage. It has been concluded that Java is the most appropriate language to be used for teaching computer science concepts. The reason that programming is so important is that it directs a computer to complete these commands over and over again, so people do not have to do the task repeatedly. Instead, the software can do it automatically and accurately. Modern human life is greatly influenced by computers. And the computer is run by a computer program. Computer programs are arranged by programming languages, therefore they are the basis of all the conveniences.

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