Performance Based Evoluation of Programming Languages

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Abstract— In the computer science curriculum, programming language holds a central importance as it enables the programmers to develop software more effectively. Every year, multiple programming languages are proposed, designed and implemented to keep up with the changing programming paradigms, hardware evolution, etc. The current article presents a comparative study of three programming languages C, Java, and PHP. Different aspects of the languages were studied in order to know their structure. Additionally, the results received from all three languages were implemented on a medical theory to analyze the performance.

Index Terms— Programming languages; Java; comparison; performance analysis.

1 Introduction

Programing Language, or computer programming language, is a formal language that allow us to give instructions to a computer in a language the computer understands. Programing Languages comprise a set of instructions, which are used to create different computer programs to implement specific algorithms. A lot of programming languages have been made, and more will be created in future. The computer engineers are using different kind of programming languages for the development of various software applications according to their requirements. Most of the software engineers are facing different kind of challenges during the development of software; they overcome these challenges by adopting different tools, techniques and engineering methods. The professional engineers must be aware of all the issues regarding the development of software applications because they are only who are concerned to design, develop and use of software application [1].

With the rapid development of software industry, additional and more individuals need to learn programming languages. Choosing the right tool at the right time can satisfy all requirements for given problem. Only a single language is not an appropriate solution for all kind of problems, some languages are better suited for specific applications than other. To select language for a specific work, the developer has to be learned what is the actual domain of the problem and has to study the features of the programming language either it is suitable to overcome that problem or not. Moreover, each programming language has its own qualities, attributes and paradigms [2]. The discussions on the comparison of programming languages are always stayed in spotlights, which language is best suited to their need, so every researcher must share their experience with others that will be much helpful. It is commonly known that FORTRAN is fastest programming language and C++ is too hard to learn [3].

Currently, various kind of powerful programming languages are being used for the application development; here two interesting questions are arising: (1) which language is suitable for development; (2) which language has good characteristics to decide that the term evaluation plays the vital role to get results. Evaluation is a process to measure methods, techniques and performance of programing languages. This study therefore is all about to evaluate different characteristics of the programming languages, especially three programming languages as C++, Java, and PHP. The rest of this paper is organized as follow: the related work is presented in section 2, in section 3, 4 all detailed information about this research approach methodology and results are described, in section 5 conclusion and future work is discussed.

2 Related Work:

The research approach to compare the programming languages is really a very hot topic nowadays in era of digital world. Many of the researchers are working for years on it and several approaches have been proposed and more will be proposed in the near future. Mathew Stephen et al [4] defined concepts of MDE (Mode Driven Engineering) and performed comparative study of EMF (Eclipse Modeling Framework) supported model transformation languages like EMT, Two phases of language design and implementation are linked with each other, change in one can affect other phase, and author emphasizes relation among them.

Several languages on different memory architecture, collision of different programming language, features and performance of aligned applications were evaluated, in result it was founded that writing of code in parallel application is much easier. The issues about HEP (High Energy Physics) applications, author declared FORTAN as traditional and one of mostly used language for HEP during 90's. In this paper we have described four famous programming languages C, C++, C#, JAVA and also described their features, advantages and disadvantages of all, author considered C for System Programming and Hardware Applications, C++ for Application Software, Device Drivers, C# for Web Application, while java has three forms J2SE for Desktop Application, J2ME for Mobile Phone Applications, J2EE for server programming. The algorithm was presented for combination and permutation calculator in all languages, two parameters memory consumption and Runtime requirement were considered to get results.

Characteristics of five languages and made their comparison in graph clustering scenario. The graph clustering task was implemented and executed in all languages C++, Java, C#, F# and Python, author calculated results about runtime

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memory and code size and found C++ as fastest language. Researchers declared that code is reduced when you are going to use Python. In this study compared two programming languages Python and C#, in results author described Python is a better choice for those applications which focus on speed and performance, because open source libraries can be used with it to increase performance, at the other side author described that C# is integrated with Microsoft it has no open source libraries, so C# is better to use with the application integrated with Microsoft [4]. Languages to compare Java and C#, both languages are enterprise technologies and have almost similar syntax, mostly being used with large scale projects, high load systems, complex architecture and big data applications [5].

However, we can't choose any one language to say it is better because every language is concerned with specific kind of applications, choosing a programming language depends on user requirement and application specifications. Research work into two sections, in section one author described method for producing video tutorials over the web-based application, in second part the author described the system in which video tutorial were stored to make comparison of four programming languages C++, C#, JAVA and PHP, the system was to provide bridge for programmers to learn these programming languages over the web page [6].

3 METHODOLOGY:

The study has carried out to investigate the comparative analysis of three programming languages C, PHP, and JAVA. These languages are studied by different aspects and a medical theory is followed and implemented in the languages to get results.

3.1 C Programming:

C Programming language is one of most popular programming languages, which is most flexible and versatile language. It is concerned with operating systems and mostly of micro controllers to operating system are written in C.

3.1.1 Variable:

Variables are chunks for memory use to store runtime information, before executing any statement or algorithm to make calculations all the required variables must be declared initially.

3.1.2 Data Types:

We have different kind of data to be stored in variables, that's why variables are classified in different categories according to the data. C programming language is correlated with five basic data types.

- **Integer:** The whole number
- **Float:** Floating point Value
- **Double:** Large range floating point value
- **Chart:** A Character (Alphabet)
- **Void:** Special or Valueless

An integer is a data type which accepts numeric or non-decimal numeric value to be stored. Some system used to store int (Integer) as 2 bytes within range -32,768 to 32,767, and some system used 4 int (Integer) as 4 bytes within range 2,147,483,648 to 2,147,483,647.

TABLE 1
RANGE OF TYPE SPECIFIES SHORT AND LONG

Type	Bytes	Range
Short	2	-32,768 to 32,767
Long	4	-2,147,483,648 to 2,147,483,647

Double and Float data types accepts decimal numeric values to be stored in variable. Both are used to store floating point data, the difference is only that the double can hold more data floating data as compare to float, while Char is used to store a single character.

TABLE 2
RANGE OF TYPE SPECIFIES FLOAT, DOUBLE & CHAR

Type	Bytes	Range
Float	4	1.2E-38 to 3.4E+38
Double	8	2.3E-308 to 1.7E+308
Char	1	-128 to 127 or 0 to 255

Variable in programming languages have specifies qualifiers.

3.1.3 Qualifiers:

Qualifiers are reserved keywords acclimated to modify properties of variables, the C programming language have two types of qualifiers.

- Constant: The variable which value defined once and can't be modified or a variable which have unchangeable value is known as constant. Constant variables always refer to fixed value, the constant variables are not concerned with data types, the can be used as any of defined data types.
- **Syntax:** define_data_type, variable_name;
- **Volatile:** The variable which value is changeable or keep changing without any exact assignment by the program, these types of qualifiers are called volatile. If programmer going to store current time of operating system in a variable so value keeps changing at the runtime in ever milliseconds, that kings of variables are known as volatile variables.
- **Syntax:** Volatile_data_type variable_name;

3.1.4 Specifiers: instruct the compiler what and where to store variable value and defines lifetime of variable, it is also used to print formatted output or to store input, and it is called formatting string.

Syntax: Specifier Data_Type Variable_Name;

TABLE 3
TYPES OF STORAGE CLASS SPECIFIES

Storage Specifier	Description
Auto	Storage place: CPU memory Initial/default value: Garbage value Scope: Local Life: Within the function only.
Extern	Storage place: CPU memory Initial/default value: Zero Scope: Global Life: Till the end of the main program. Variable definition might be anywhere in the C program.

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Static	Storage place: CPU memory Initial/default value: Zero Scope: Local Life: Retains the value of the variable between different function calls.
Register	Storage place: CPU memory Initial/default value: Zero Scope: Local Life: Retains the value of the variable between different function calls.

3.1.5 Compiler of C Programming:

C programming language compilers have four steps, the first step is preprocessor which load the code and send it to compiler, the compiler convert that code in assembly code. After that, the assembler creates object code, then variable references are resolved in link editor and it also combines library functions with main () function to execute the source.

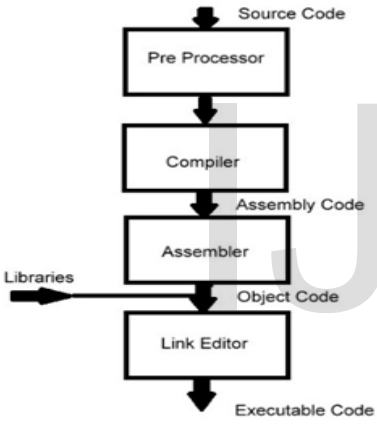

Figure 1: C Programming Language Compiler

3.2 Java Programming Language:

Java is an object-oriented programming language for creating and running software programs, and it is used for general purpose. Java is a most powerful tool for software development purpose, Java is a platform independent it can be run on any platform like Mac OS X, Linux, and Windows. It has three development environments JEE (Java Enterprise Edition), JME (Java Micro Edition) and JSE (Java Standard Edition).

• **JEE (Java Enterprise Edition):** JEE is designed for server applications; it provides facility for multi-tier architecture software.

• **JME (Java Micro Edition):** It is designed for embedded devices, like mobile phones etc.

• **JSE (Java Standard Edition):** It is designed for standard programs, mostly used for programming purpose to create portable generalpurpose applications, it has several libraries and packages to enable user to get access networks and graphic interfaces.

• **JVM (Java Virtual Machine):** Java virtual machine enables computer device to run java codes. It also enables java compiler to compile code of other languages.

• **JRE (Java Runtime Environment):** It contains JVM supporting libraries and another compound to run java, it doesn't compiler and debugger.

• **JDK (Java Development Kit):** It contains JRE and tools such as compiler and debugger which enable user to develop java applications.

3.3 Data Types in Java:

The data types in java programming language are classified in 2 categories primitive and non-primitive. Primitive data type contains Integer, Characters, and floating Values and Boolean and Non-Primitive includes Classes and Arrays.

TABLE 4
RANGE OF DATA TYPES

• Integer: Integer data type hold whole numbers, and it is also classified as byte, short, long, long as shown in above table [7].

• Floating Point: It holds fractional value in memory and occupies 4 bytes with range 3.4e−038 to 3.4e+038 and double floating-point reserve 8 bytes with range 1.7e−308 to 1.7e+038.

• Boolean: Boolean data type stores discrete value, which has two sates true or false.

• Character: It stores character value in memory with size of 2 bytes.

• Identifiers: Identifiers are composed of letters, numbers or special characters like ($, _), we can say that identifiers are user defined names of variables which may contain values.

3.3.1 Keywords:

Keywords are reserved / pre-defined words that have specific functionalities, every programming language have its own sets of keywords.

3.3.2 Literals: Literals are kind of variables which contain constant values, it can be numeric, character, and Boolean or String.

3.3.3 Operators: Operators are signs / symbols used to perform specific operations, operators are dependent of operands, and operands are the values on which operations are going to be performed.

TABLE 4
RANGE OF DATA TYPES

Type	Size	Range
Byte	1 Byte	−128 to 127
Short	2 Bytes	−32768 to 32767
Int	4 Bytes	−2,147,483,648 to 2,147,483,647
Long	8 Bytes	9.223,372,036,854,775,808 to 9,223,372,036,854,755,807

3.3.4 Array: Array is a kind of variable which contains homogenous form of data, it has ability to contain one or more than one values in its memory.

• Example of Array declaration and initialization

```
Class Qadeerfirst
{
Punlic static void main (String args[])
{
Int temp[]=new int[4];     // Decleration of Array
```

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```
Temp[0]=11          // Value Initialization of Array First Index
Temp[1]=22
Temp[2]=33
Temp[3]=44
For(int i=0; i<temp.length;i++) { System.out.println(temp[i]); }
}}
```

3.3.5 Java Compiler: Compiler first analyzes the code and statements written by programmer. Java compiler read the code from the Text file to produce a class file which will be used by java virtual machine. JIT (just in time) java compiler works with JVM which also can run the platformindependent code. It converts code into machine language for different hardware. Java programs execute in the Java Virtual Machine, which makes it an interpreted language [10].

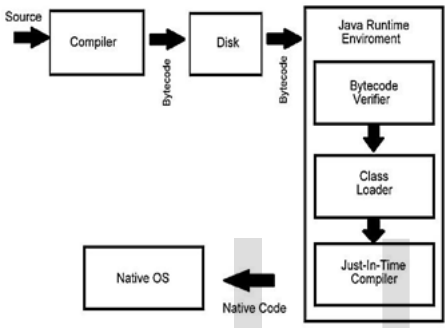

Figure 2. Java Code Compile and Execute

4. PHP (PREPROCESSOR HYPERTEXT):

PHP is an open source server-side scripting language used to create dynamic web-based applications and it works with almost all servers like APACHE, IIS etc. PHP is platform independent language which can be run anywhere it supports Windows, Linux, Unix, Mac OS X etc. [8].

Syntax:

```
<?php
    Echo "I'am Qadeer It Is My 1st Program";
?>
```

4.1 Variable and Data Types: Variable is chunk of memory which holds some data, and the data is categorized in various data types. PHP have following data types.

- String (text, alphabets)
- Integer (Whole Numbers)
- Float (Decimal Numbers)
- Array (Multiple Values in One Variable)
- Boolean (Discrete Value 0,1 / true, false)
- Object (stores object of the defined class)
- Null (Special data type, No Value)
- Resource (Reference to functions, external resources)

4.2 Variable declaration and initialization: In every programming language there are some protocols to be followed to reserve a chunk of memory. In PHP there is no need to define data type, it has an ability to recognize type by initialized value. But it has some variable naming rules to be followed. Variable name must be start with $ sign, it can be named as alpha numeric case sensitive characters and it allows only "_" sign.

```
<?php
$name="hello I am Qadeer";    //String Value
$age=28;                      // Integer Value
$height=5.4;                  // Floating Value
Echo $name."<br/>";
Echo $age."<br/>";
Echo $height;
?>
```

4.3 Three Tier client server architectures: PHP script follows client server architecture, in which client sends the request toward server for getting services through browsers. The three tiers in architectures are following [9].

- **Presentation Tier:** Presentation Tier is GUI (Graphical User Interface) of services over the web-based application, which connects client (End User) with the 2nd tier.
- **Application Tier:** It is also known as Middle Tier or Logic Tier which is responsible to control all functionalities of provided services.
- **Data /** where all services are

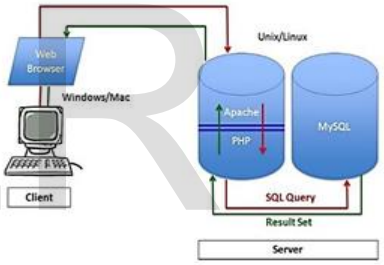

Figure 3. Three Tier Architecture

In above figure mechanism of architecture is defined. Firstly, the client sends the request from the GUI to Apache Server using web browser, server (Application tier) receives the request and makes business decisions to get services from database server according to the user request, at 3rd stage database server get request from application tier and respond it back, Application tier receives response data and send it to the presentation tier.

5. IMPLEMENTATION OF MEDICAL THEORY:

In this study, we have created code to calculate Resting pulse rate, Maximum heart rate, reserve heart rate of human body at differing ages, we have taken an informatics medical chart which describes facts concerned with different stages of pulse rates. The functionalities of human body are working as machine, and heart is a central part of it. To manage all systems of human body the heart rhythm is to be maintained, bit in normal life people are oblivious of what they are going through. Each part of human body needs blood to be circulated which is basically pumped by heart, so heart rate is a cen-

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tral process which defines rate of circulated blood in whole body per minute [10].

TABLE 5
DIFFERENT STAGES OF HEART RATE

	Bradycardia (Slow Heart Rate)	Tachycardia (Fast Heart Rate)	Normal	Ideal
Heart Rate	<60	>100	60 to 100	50 to 70
Healthy People	1. Being physically fit 2. A. Medication (Propranolol or Metroprolol) 3. Sleep	1. Exercising 2. Nervous or Excited 3. Using Stimulant		
Signs of Disease	1. Heart Attack or Heart Disease 2. Infection (Lyme or Typhoid disease) 3. Potassium in Blood Hyperkalemia 4. Underactive thyroid gland	1. Infections/Fever 2. Heart Problems (Cardiomyopathy, Atrial Fibrillation, Ventricular Tachycardia) 3. Medication (EPiPen) 4. Low Blood Potassium 5. Overactive Thyroid gland or too much thyroid medication 6. 6. Anemia 7. Asthma or Breathing Trouble		

5.1 Table 5 defines different stages of heart rate and causes among healthy people, it also describes signs of disease regarding mentioned pulse rates. This Table is created according to the research which was published in Harvard Health Publishing Journal in August 2017. We considered above medical chart which describes all information regarding different heart rates and we compared our collected data with it by assigning values in C Language Program. According to medical science theory a metaanalysis was conducted, the meta-analysis defines the maximum heart rate is strongly and inversely related to the age, and at the training zone two numbers 0.7 and 0.85 are considered for strong intensity exercise. We considered this equation to calculate different results regarding heart rate and the real time data was collected for calculation. The real time data was collected from 3 different objects of different ages, object one was a young boy up to age of 18, object two was to be around age of 36 and object three was around age of 44. Firstly, we checked the resting pulse rate of that object by following the equation (1) RHR, after calculating resting pulse rate we calculated maximum heart rate by following equation MHR, here 220 is supposed maximum heart rate to calculate actual maximum pulse rate. The formula for calculating heart rates are adopt from the medical theory proposed by Hirofumi Tanaka et al, the theory defines experiment which was conducted on 445 people to find results.

5.2 Equation for Calculating Heart Rates:

RHR (resting heart rate) = CP (calculated pulse) for15 Sec * 4.

MHR (maximum heart rate) = 220*(training zone numbers) Age.

HRR (reserve heart rate) = (MHRRHR).

5.2.1 We have implemented above data chart and equations in three different programming languages to find results.

6. RESULTS:

In this study, we have implemented a medical theory in three different programming languages C, Java and PHP, and the implemented programs were executed three times because we considered three people of different ages to get results from the medical chart and we also evaluated performance of the considered languages, the following table shows the results.

6.1 In Table 6, total elapsed time of executed program in C Programming language is written in milliseconds as well as in microseconds.

TABLE 6
PERFORMANCE OF C PROGRAMMING LANGUAGE

Attempt Time	Elapsed Time (Milliseconds)	Elapsed Time (Microseconds)
1st	13352	13352000
2nd	13385	13385000
3rd	14101	14101000

6.2 In Table 7, total elapsed time of executed program in Java Programming language is written in milliseconds as well as in microseconds which describes performance.

TABLE 7
PERFORMANCE OF JAVA

Attempt Time	Elapsed Time (Milliseconds)	Elapsed Time (Microseconds)
1st	8908	8908000
2nd	8745	8745000
3rd	8890	8890000

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6.3 In Table 8, total elapsed time of executed program in PHP Programming language is written in milliseconds as well as in microseconds to know performance.

TABLE 8
PERFORMANCE OF PHP

Attempt Time	Elapsed Time (Milliseconds)	Elapsed Time (Microseconds)
1st	7870	7870000
2nd	7901	7901000
3rd	8342	8342000

TABLE 9
CALCULATED PULSE RATE IN IMPLEMENTED PROGRAMS

	1st Person	2nd Person	3rd Person
AGE	18	36	44
RHR	76/Min	80/Min	88/Min
MHR	136/Min	118/Min	110/Min
HRR	60/Min	38/Min	22/Min

We considered three different people of different ages 18, 36, and 44 and calculated pulse in 15 sec and calculated value in our designed program to get final results. RHR is pulse rate at resting point, MHR is Maximum pulse rate and HRR is the reserve pulse rate which defines pulse rate during cardio or exercise. The person having HRR 60 have ideal pulse rate, and other two persons having HRR < 60 are related with Bradycardia as shown in table 5. After comparing Table 4, 5 & 6 we can say that PHP performance is fast as compare to other two languages, but the main thing is all about designed Algorithm, an efficiently written algorithm will work faster no matter what language you are using.

7. CONCLUSIONS:

Each programming language is designed with its purpose and have suitable fields to work. However, the evaluation of the languages has been conducted based of performance, so we did comparison of three languages and found above results by executing similar program in all, and we found C language is suitable for system programming applications. Controlling large scale programs will be difficult job in it because it focuses on procedural programs patterns and it has also machine level programming capacity, that's why it is mostly used for hardware related programs. Java Programming language is an object-oriented programming language and it is considered slow because it uses an extra layer between systems and programs, java works with huge libraries, Java applets and virtual machine initialization can slow down the program process. On the other hand, PHP is also object-oriented programming language which is specially designed for creating web-based applications it has capability to run its code little bit faster than java and C because it has few resources to boot. In the conclusions of this study, we can say that every language is made for performing specific functionality and the performance of languages depends on efficiency of algorithm written by programmer.

Future Work: The study was based on performance evaluation, in future these languages can be compared by considering many factors like reliability, flexibility, popularity etc.

References

[1] Omar Portillo, (2018). "Improving the Testing of Java Garbage Collection through an Efficient Benchmark Generation" International Conference in Software Engineering Research and Innovation (CONISOFT).

[2] Rajeev Alur, Rastislav Bod´ık, Garvit Juniwal, Milo M. K. Martin, (2017). "Syntaxguided synthesis. In FMCAD" pp. 1–17.

[3] Alexander L. Gaut, Mark Brockschmidt (2016). "A Probabilistic Programming Language for Program Induction." Published in Arxiv 2017.

[4] H. Masuhara, H. T., and A. Yonezawa (2005). "Aspectual Caml: an aspectoriented functional language." In Proc. of the tenth ACM SIGPLAN International Conference on Functional Programming Volume 3(Issue 3): pages 320–330.

[5] Jesús Sánchez Cuadrado, J. G. M. (July 2008). "Modularization of model transformations through a phasing mechanism." Software and System Modeling Volume 8(Issue 3): pp 325– 345. [6] K. Chen, S.-C. W., M.Wang, S.-C. Khoo, and C.-H. Chen (2007). "A compilation model for aspect-oriented polymorphically typed functional languages." SAS 07 Proceedings of 14th International Conference on Static Analysis Pages 34-51.

[7] Kennedy, K., Koelbel, C. and Schreiber, R. (2004). "Defining and Measuring the Productivity of Programming Languages" International Journal of High Performance Computing Applications Volume 18(Issue 4): pp. 441–448.

[8] Oguntunde, B. O. (June 2012). "Comparative Analysis of Some Programming Languages." Transnational Journal of Science and Technology Volume 2(Issue 5).

[9] Baishakhi Ray, Daryl Posnett. (October 2017). "A large-scale study of programming languages and code quality in GitHub". Magzine Communications of the ACM Volume 60 (Issue 10). Pages 91-100.

[10] Sebastian Nanz, Carlo A. Furia, (August 2014). "A Comparative Study of Programming Languages in Rosetta Code" Software Engineering Proceedings of the 37th International Conference on Software Engineering (ICSE'15), pages 778-788. [11] Henri E. Bal, Janiefer G. Steiner, Andrew S. Tanenbaum. (September 1989). "Programming languages for distributed computing systems" ACM Computing Surveys (CSUR) Volume 21 (Issue 3). Pages 261-322.