C LANGUAGE AND JAVA LANGUAGE

A software can be coded in different programming languages. However, choosing an appropriate programming language is an important factor to code a good software. Because choosing a suitable programming language for a software not only makes programmers work easier but also it makes software better. For this reason, a programmer must consider a project entirely and compare programming languages to find the appropriate language which satisfy software needs. For example, if a programmer wants to code a web software, C++ is not the best option, some languages such as JavaScript, C and, Python have advantages over C++ on web software. It is a fact that all languages have disadvantages and advantages over each other. Like the other languages, although C and Java languages are similar in some respects, they have different properties.

A difference between C and Java languages is readability. Readability is the measure of how easily a language can be read and understand. "Code is written once but read many times" phrase shows the importance of the readability of a language. Both languages have post-increment operator, pre-increment operator, and addition assignment operator which decrease the readability of a language. However, Java is slightly more readable than C language. The difference is caused by five factors. Firstly, their paradigms are different. Java is one of the object-oriented programming languages, but C is one of the procedural programming languages. Being object-oriented programming language increases readability of Java language because of encapsulation concept which refers to the bundling of data with the methods that operate on that. Also, polymorphism concept which refers to the ability of a variable, function, or object to taken on multiple forms increases the readability of Java language. Secondly, C language is much closer to machine language than Java. Although readability increases from machine language to high-level languages and readability of C language higher than Assembly language, readability of C is lower than a high-level language such as Java. Thirdly, not having enough data types makes C more unreadable. For example, use of 1 or 0 due to lack of Boolean expressions decreases the readability of a language. Fourthly, function overloading increases readability of Java. Because having multiple function with different names doing the same operation

may be confusing for programmer. Lastly, C language has too much simplicity which decreases its readability. For example, an array can be passed as function arguments in three different ways in C.

Another difference between C and Java languages is writability. Writability is not only the ease with which a language can be used to create programs but also it is a criteria that it may conflict with readability. For example, as in the mentioned above, expressivity (such as using "i++" instead of "i = i +1") decreases the readability of a language but increases the writability of a language. Although both languages have that kind of features to increase the writability, Java is little easier to write than C. It is caused by three factors. Firstly, syntax of use of pointers decreases the writability of C language. Because pointer is a dangerous operator due to direct accessing to memory. For this reason, writing secure and reliable code in C is hard. Programmer must check every line of code carefully. Secondly, memory operations decrease the writability of C, but Java has a garbage-collector to do memory operations automatically. In this way, programmer can write code without considering where memory must allocate or free in Java. Thirdly, not having enough datatypes decreases the writability of C language. For instance, there is no String datatype in C language. A programmer must use character array which is harder to manage to use strings. Additionally, not having operator overloading decreases writabilities of both languages.

One of the major differences between C and Java languages is safety. Safety refers to being able to write code without harming the hardware. Java is safer than C language. Because Java language has Java Virtual Machine to run Java programs. Unlike Java language, C language does not have a virtual machine to run C programs. The advantage of virtual machine usage is they provides to access to hardware indirectly. This feature prevents hardware get damaged. Also, use of pointers effects the safeness of the C language. Because pointers are powerful things that can directly access memory addresses. So that, memory problems may occur with improper use of pointers.

Another important difference between C and Java languages is reliability. Reliability is the ability of a program to comply with its specifications, under all conditions. In this perspective, Java is slightly more reliable than C for three reasons. Firstly, Java has stronger type checking than C. Type checking is affects reliability of a language enormously. Because run-time type checking is more

expensive than compile-time type checking. Java checks all variables and expressions at compile-time. However, C does not check whether the parameter of a function and the parameter which is sent to function match and this error may led to countless program errors. Secondly, Java has better exception handling mechanism than C. For example, try-catch statements are used to catch exceptions before getting errors in Java. On the contrary, C language does not have try-catch statements. For example, a programmer wants to write a function which takes two parameter and returns the division of them in C language, if the divisor is 0, the function must return specific value representing an error code. In Java, function can throw an exception like "DivisionByZero" easily. Thirdly, C language allows to refer to one location in memory with more than one name with pointers. This feature provides so much feasibility to programmer but, in an improper use of this feature, memory leaks or memory errors are the inevitable result.

One of the important differences between C and Java is cost. There are many aspects to cost of a programing language. Firstly, the cost of training programmers in Java is lower than C language. This difference is caused by their paradigms and their syntax. It is easier to learn an object-oriented language (Java) than procedural language (C). Also, being low-level language (being close to machine language) decreases learnability of C language. Second, the cost of writing programs in Java is lower than C language. Because writing programs in a language completely depends on writability of the language. Thirdly, cost of compiling programs in C is lower than Java. Because of the Java Virtual Machine, Java program needs another layer before instructions are sent to the hardware to execute. However, C programs is executed in hardware directly. Fourthly, the cost of executing programs written is cheaper in both languages which has static type checking than some languages which has dynamic type checking such as JavaScript, Python, and PHP. Because static type checking is performed at compile-time. Fifthly, the cost of the language implementation system is cheap in both languages. Because the compiler/interpreter systems are free in both languages and both languages are hardware independent. Sixthly, the cost of poor reliability is lower in Java than C. As it is mentioned in reliability paragraph, Java language has stronger type checking than C language. Weakness of type checking system of C language costs a lot due to run-time errors in critical software. Lastly, the cost of

maintaining programs is lower in Java than C language. As it is mentioned in readability paragraph, readability of Java is higher than C language. Because of the lower readability of C language than Java, understanding code, maintaining programs, and adding new functionality is harder in C than Java. In conclusion, despite Java and C are close to each other in some part about cost, C language is more expensive than Java in most parts.

Efficiency is one of the differences between C and Java language. C language is faster than Java language because of three factors. Firstly, syntax of C language is closer to the machine code. So, it is easier to convert C codes into machine code. Secondly, Java is an interpreted language, but C language is compiled language. Interpreting code is slower than running the compiled code because the interpreter must analyze each statement in the program each time, whereas the compiled code just must each statement just once. Thirdly, some features of Java languages handled by language itself, whereas they must handle by programmer in C such as freeing memory, allocating dynamic size of memory. Extra features which are handled by language decrease speed of a language.

Semantics is a difference between C and Java language. Their semantics are different because of three reasons. Firstly, the datatypes in both languages are different. For example, C language does not have boolean, and strings, and classes. On the other hand, Java language does not have pointers, unsigned datatypes, enums, and unions. Furthermore, Java has some classes which wrap a value of the primitive datatypes in an object such as Integer, Character, Double. In this way, some functionalities are added to the primitive datatypes. For example, Integer.compareTo(Integer) compares two integers. Contrary to these differences, both languages have primitive datatypes (int, char, float, double, void), functions, and arrays. Secondly, the control statements in both languages are different. For example, C language has goto statement which is referred to as unconditional jump statement. Also, Java language has foreach statement which is a control flow statement for traversing items in a collection. In opposition to these differences, both languages have conditional statements (if-else, switch), loop statements (do-while, while, for), and jump statements (break, continue).

Another difference between C and Java language is their paradigms. Programming paradigms are a way to classify programming languages based on their features. So, there is no good or bad in

comparison of two paradigms. Java is an object-oriented programming language, whereas C is a procedural-oriented language. There is a lot of differences between object-oriented programming language and procedural-oriented programming language. Firstly, the focus of object-oriented programming is breaking down programming tasks into objects, but procedural-oriented into functions. Secondly, object-oriented programming gives more importance on data hiding than procedural-oriented. For example, private, public, and protected keywords set the accessibility of data in Java. Thirdly, there is some mechanism which supports the concept of code reusability in Java contrary to C language. For example, derived classes can use methods of base class by inheritance increases code reusability. Fourthly, there is no function overloading which enable to supply different semantics for a function depending on the types and number of its arguments in C language. On the other hand, Java supports function overloading. Lastly, Java gives more importance data over functions contrary to C language.

One of the similarities between C and Java languages is syntax. Syntax refers to the rules that define the structure of a language. Because syntax of Java is largely influenced by C++ and C, C and Java languages have similar syntax in many ways. For example, to define the start and end of a code block, C and Java languages use curly braces. Both languages use semicolon to define end statements, use "//" and "/* … */" for comments, use loops (while, for, do-while) and conditional statements (switch, if-else) similarly, use same keywords for data types (int, float, double, char). However, they have some differences between their syntax. It is caused by the paradigms of the languages. For example, because Java is object-oriented language, it has some keywords which C languages does not have such as public, private, new, class, interface, extends, implements, etc. Also, C language has own keywords such as auto, signed, unsigned, union, struct, etc.

To sum up, all languages have disadvantages and advantages over each other. For this reason, it is programmer's job to find the most suitable for software requirements. In this way, programmer may write code easier, and the performance of software may be better. To find most appropriate language for a software, there are lots of criteria for comparison. These are readability, writability, safety, reliability, efficiency, and cost. Programming paradigm, syntax, and semantic are the other

factors to consider when choosing a programming language. It must be decided by the programmer that which criteria should be given most importance or which programming paradigm is good for the software. For instance, syntax of Java and C languages are similar, but they are different because of their readability, writability, safety, efficiency, and cost. For this reason, if the programmer gives most importance on syntax, both languages are selectable. Contrary to this example, if the programmer gives most importance on efficiency, C language is better option than Java. Also, if the programmer gives most importance on cost, readability, writability, etc. Java language is better option.