

# CS 131 Homework 6 Report

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## Abstract

This report examines different programming languages as potential contenders to write an application for XuFly's flynetting robot swarm. We analyze the advantages and disadvantages of C++, Go, Java, and Python, and determine which programming language will result in the most efficient algorithm. We conclude that Python would be the best option due to its extensive libraries, support for machine learning technologies, efficiency, and usability.

## 1. C++

C++ is an object-oriented programming language, and the oldest in comparison to Go, Java, and Python.

### 1.1 Advantages

C++ is a compiled, statically typed programming language. Being a static typing language, variables are type checked during compile time. This makes for more reliable and safe code, since any type mismatch errors will be caught ahead of time [5].

C++ is considered a lower-level language, unlike Python and Java, making it faster for the computer to understand and execute the program [2]. Being one of the fastest programming languages is helpful in making an efficient robot swarm.

C++ is also compatible with the technologies Coral SoM, OpenVINO, TensorFlow Lite, TensorRT, and Jetson Xavier NX.

### 1.2 Disadvantages

There are many disadvantages of C++. C++ does not have an automatic garbage collector; it must utilize direct allocation. There are also security issues with C++ with the use of global variables, pointers, and friend functions [4].

## 2. Go

Golang is an open source programming language that is fairly new in comparison to C++, Java, and Python.

### 2.1 Advantages

Go is also a compiled, statically typed programming language [3]. This means that variable types are checked during compile time. This serves as an advantage because fewer errors will occur during runtime since they are caught when compiled, meaning that code will run faster and is more reliable. Go also has strong duck typing so it is even easier to type check. This means that objects are determined by their properties and methods rather than object itself. Another factor that makes compilation factor is that Go does not use any pre-processors.

Go also has a garbage collector, so developers don't need to manually allocate and deallocate memory as one has to do when programming in C++. This also improves code efficiency. On top of that, Go comes with asynchronous primitives which can be used to increase efficiency.

## 2.2 Disadvantages

Go has the following disadvantages. Static type checking can slow down the programming process since the developer needs to know all the types of functions and variables while programming [5]. Another reason that programming in Go would be a little more time consuming is that it does not have an IDE. The developer would need to develop and test the program separately, making work less productive. It also tends to print verbose error messages, making error handling complicated [3].

## 3. Java

Java is one of the most commonly used programming languages.

### 3.1 Advantages

Java does static type checking, in which variable types are checked during compile time. This makes code more descriptive and easier to debug. Additionally, there would be fewer errors during runtime because type mismatch errors would be caught during compile time. Therefore, code will also run faster after compiling because there is no need to constantly type check like a dynamic type-checked language has to [5].

Java implements an automatic garbage collector, so memory does not need to be manually allocated and reallocated like in C++. The garbage collector uses the mark and sweep method, which is done in two rounds. It first sweeps through the objects and marks objects that are unreferenced, and then sweeps again to delete these marked objects. Although this is a two-fold process, garbage collection is done on a

separate thread, so it does not hinder performance [7].

Java is known to be portable. It is run on the Java Virtual Machine (JVM), which means it can be executed by various computer architectures. Programs are compiled into byte code which the JVM then executes as runtime. This is not as fast as execution of machine instructions like it is with C++, but it is faster than Python. Java uses multithreading and has support for concurrency and parallelism.

In addition to these main advantages of Java, it is also supported by many IDEs, which makes testing and debugging easier, and it works with the technology TensorFlow Lite.

### 3.2 Disadvantages

Although static type checking is an advantage of Java, it also serves as a disadvantage. The programmer needs to know all the types for the variables and functions when writing the code. Therefore, the early development stages can take a longer time and time may be wasted and making sure everything returns the right type. Additionally, this strict type checking makes abstraction more difficult [5].

## 4. Python

Python is a general purpose interpreted language that is a popular choice for AI development.

### 4.1 Advantages

Python uses dynamic type checking. In dynamic typing, the variable type is determined only at runtime. This makes

programming easier because the developer does not need to know all the types, therefore making a quicker implementation, which is important with machine learning models. Python is also a duck typing language. This means that an object is defined by what it can do instead of what it is. This, along with dynamic typing, increases performance and efficiency [5]. On top of that, Python is extremely succinct and user-friendly; programs written in Python are significantly shorter than those written in Java and C++.

Python also uses an automatic garbage collector to allocate memory, which is better than C++'s way of allocating memory because it is a faster and more efficient way to free memory. The collector is implemented with the link/reference method, in which each object has a count that depends on the number of times that object is being referenced by another object. The object can only be de-allocated when its count is at zero.

Python has numerous well-maintained libraries and packages that support machine learning, like Numpy, Scikit-Learn, and TensorFlow [2]. Additionally, being an interpreted language, Python is never compiled so it is flexible and portable. It can run on a variety of platforms, including Linux, Mac OS, Windows, and UNIX [1]. Also, it is compatible with the technologies Coral SoM, OpenVINO, TensorFlow Lite, TensorRT, and Jetson Xavier NX.

## 4.2 Disadvantages

Dynamic type checking has some drawbacks as well. Because types aren't determined

until runtime, there is a bigger chance for errors to occur and it makes debugging more difficult [5]. Additionally, while the automatic garbage collection makes memory management better than that of C++, the link/reference method could be inefficient. It uses extra memory to store the reference count and is continuously updating it when the other objects reference it, which translates into more operations and a decreased performance. Python has a slower compilation and execution time in comparison to compiled languages, since what is being executed is interpreted byte code instead of machine instructions [6].

Perhaps the biggest disadvantage of Python is its lack of ability to support multithreading. Instead, it uses a Global Interpreter Lock, which is a mutex that prevents multiple threads from executing on an object simultaneously. Therefore, parallelism is blocked and performance and efficiency is decreased [6].

## 5. Conclusion

All four languages have strong advantages and disadvantages, but my research has led me to believe that Python would be the language best suited for XuFly's robot swarm. Python's dynamic and duck typing increase performance and efficiency, which is necessary for the machine learning algorithm to be implemented. Additionally, Python is supported by many of the technologies that XuFly wishes to use. It's easy to use with its comparatively more simple syntax and extensive collection of libraries.

## References

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