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# IC Practice 1

Employment prospects of a computer engineer specialized in software/hardware acceleration



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## Task 1: Research on software and hardware acceleration positions

### Brief Statistical Summary

We start with a summary of the information we gathered about the job offers found (the information can be read in the spreadsheet attached along the report).

Regarding salaries these jobs offer competitive compensation packages, often exceeding average salaries of the market due to the specialized nature of the work. In addition to financial rewards, these roles often come with the opportunity to engage in important projects and collaborate with big companies or universities. With an average salary of \$130,000, these jobs offer great working conditions.

General aspects that deserve to be highlighted:

- Many of these jobs are in the field of modern research.
- These jobs have the highest salaries in the United States, often doubling the salaries found in Spain in most cases.
- Many of these positions focus part of their study on AI models research and design, probably because of the novelty of the technology.
- The main and most common feature of these jobs is to integrate parallelism to accelerate applications using GPU cores.
- The most valued programming languages used are C++ and Python, the main system is Linux and the most used GPU parallelization platform is CUDA. These four concepts are the ones that we have found the most on the offers we've looked into.

### Final Conclusion

In the modern era of computing we seek for optimization, higher efficiency and greater speed. Specialized roles, such as GPU parallelization programmers, benchmarking and optimization engineers, supercomputing performance engineers and so on, may not be the most offered or common positions but are a crucial part of the development teams when it comes to the efficiency of their systems.

Their work enables higher performance in our current technologies and also for emerging technologies like Artificial Intelligence. The increasing usage of complex simulations, data analysis and machine learning models depends on efficient and accelerated computing capabilities.

Over the next 15-20 years the viability of these roles is not only promising but also essential. The demand for these skills will probably rise since these professions offer promising career trajectories and also satisfy a very important role of the field enabling the progress of computing as a whole.

## Task 2: AI and supercomputing reaching the animal world

For this task we have created a company based on the possible necessities that we, as a society, may have in a future. The primary idea was the use of technology in order to preserve the nature and ensure wild life stability from the increasing climate changes. Our idea was that this company bases their research on biology and nature's behavior in order to predict many different factors that may affect the local fauna of a specific region. Here's some of the main information.

**Company:** EcoGuardian Systems

**Position:** Performance Optimization Engineer

**Areas:** Supercomputing, Artificial Intelligence Research, High Performance Simulations.

**Logo:** A lion with technological features surrounded by a circle, representing the use of modern advancements in order to protect wild life.



## Introductory Questions

### **What is the core responsibility of a Performance Optimization Engineer at EcoGuardian Systems?**

The core responsibility of a Performance Optimization Engineer at our company is to ensure the good performance and correct functioning of our animal behavior simulation AI models using different hardware and software enhancements. This involves integrating acceleration techniques with artificial intelligence systems to create lifelike animal behavior models, simulating their routes and migrations using many different climate factors in order to protect the wild life, and ensuring this models are seamlessly integrated into the hardware of the supercomputing clusters we use.

### **How does this role incorporate parallel programming, especially GPU parallelization?**

The role leverages GPU parallelization in the use of the different models across our supercomputing machines. Given the complexity of simulating lifelike animal behaviors and the vast amount of data involved (such as climate events, changes of the temperature, tide fluctuations, migration of groups of species and so on), parallel computing, particularly GPU parallelization, is crucial for real-time processing efficient simulations in order to have correct predictions and accelerating tasks that would be computationally intensive on traditional CPUs.

### **Which real-life sectors could benefit from the applications developed by a Performance Optimization Engineer?**

Wild life is a crucial part of our world, since it provides an equilibrium that has been maintained for ages on the planet Earth. Today, because of industrial expansion and contamination we have broken that equilibrium and now the planet is changing drastically, causing many species to go extinct because of our fault. The purpose of EcoGuardian Systems is to collaborate with many different governments and wild life conservation organizations to provide a way of researching and predicting how these animals are going to behave and will be affected in the current state of the planet, using this information to ensure the protection of the diversity of the biomes. As a Performance Optimization Engineer, you provide an efficient functioning of our systems and allow us to be able to help thousands of animals to be preserved and secure from the dangers of the new world.

## Requirements

Master's Degree or PhD in Computer Engineering, Computer Science or a related field: This ensures that the candidate has the depth of understanding required to harness the software and hardware systems we are handling. A PhD provides great research experience and problem-solving skills, so it's a big plus to apply for the job.

Experience with AI models, specially large data models: The ideal candidate will not only understand AI but will have experience with creating AI systems that use big amounts of data and synthesizes results from it. This is paramount for developing precise results from real groupal behavior information.

Strong understanding of parallel programming, benchmarking and acceleration in the software/hardware design, minimum of 4 years of professional experience using multithreading or GPU parallelization technologies: As performance enhancement is the heart of this role, a thorough knowledge of computing acceleration ensures the candidate can push the boundaries of what's possible with our clusters and AI models.

Capacity of communication in English language at a professional level. If you are not a native speaker we require at least the B2 level. Any other language capacities acts as a plus for your appliance.

## Responsibilities

**Performance Analysis:** Analyze the performance of existing software and hardware systems to identify bottlenecks, inefficiencies, and areas for improvement. This involves profiling and benchmarking the systems to pinpoint performance issues and develop a performance optimization strategy that aligns with the company's goals and objectives. Troubleshoot and resolve performance-related issues as they arise, ensuring minimal downtime and disruption to ongoing operations.

**Hardware/Software Enhancement:** Collaborate with hardware engineers to identify opportunities for hardware upgrades or modifications that can improve system performance. This may include recommending and implementing changes in the cluster's architecture. Work closely with software developers to enhance and optimize codebases. This includes rewriting or refactoring code to make it more parallelizable and efficient. Utilize parallel programming techniques, including multithreading and GPU parallelization to optimize AI models and other computational workloads.

**Benchmarking and Testing:** Continuously benchmark and test the system to evaluate the impact of optimizations. Ensure that performance improvements meet or exceed established objectives. Document performance optimization strategies, changes made to the system, and their impact. Provide regular reports to management and stakeholders on the progress of optimization efforts.

**Scalability and renovation:** Ensure that the system can scale effectively to handle increasing workloads and data volumes. Keep up-to-date with the latest advancements in hardware and software technologies relevant to supercomputing and AI. Identify and adopt emerging best practices and technologies for performance optimization.

## Salary and Conditions

Given the specialized nature of the role, a salary range of \$140,000 - \$220,000 annually ensures competitive compensation for experts in this interdisciplinary field. Also we offer good extra payments based on the job performance of our workers and health insurances.

## Technological Knowledge

GPU parallelization is essential for accelerating complex computations in various sectors, especially when dealing with large data sets or simulating real-world scenarios. Below, we mention some of the most important programming languages and technologies that fulfill the main objectives of a Performance Optimization Engineer at our company:

**C/C++ and Python:** These general languages are foundational for system programming and AI development respectively. C and C++ are commonly used for optimizing performance-critical code and multithreading programming. Python has many libraries and frameworks for AI, like TensorFlow and PyTorch, that are crucial in our models.

**GPU Parallelization:** If you're working with GPUs for parallel programming, CUDA is a very important language to be fluent with. OpenCL allows you to target a variety of accelerators including GPUs and FPGAs. Parallel programming models like OpenMP and MPI are valued for optimizing code on multi-core CPUs and distributed computing clusters, respectively. Any knowledge on this technologies is essential for the position.

**Linux/Unix:** Proficiency in the Linux/Unix operating systems is crucial, as they are used in high performance computing environments. Also the use of scripting languages like Bash is very important for the deployment in our cluster machines.

**Git/GitHub:** Being experienced with version control systems like Git is essential for collaborative development and tracking changes in codebases.

## Final Conclusions

This position, although is fake and invented by us, is based in many different real job offers we have seen searching through lots of pages. Artificial Intelligence models that use giant quantities of data are closely tied with optimization requirements for its data management and machine learning. Some real positions of software acceleration and GPU parallelization were at AI companies, so we had the idea to fuse it with a necessity that we may have in 15/20 years.

Since global warming is a big and real problem for our world and the animals that inhabit it, we thought of a company that collaborates with different governments that seek to protect their fauna, and we came up with the idea of these large AI systems running on a supercomputer that take real information of weather, changes of the environment and animal behavior to predict menaces for the wild life and report it to the organizations that take action to preserve the species. Almost like a weather forecast but informing of migrations and environmental dangers for the local fauna of many different places/biomes.

It's clear that computer optimization and hardware/software acceleration will be key in the future since AI models are rising up, and they need as much computing power as possible, so learning things like multithreading programming or GPU parallelization may be key to find a good job position in not so distant times.



## Task 3: Class debate and collected information conclusions

During the last class session we reviewed the information gathered by the different groups about the sector and the positions related to the topic of software acceleration.

As we already knew by our own investigation, the rest of the groups also found that the job in Spain and Europe offered smaller salaries compared to positions on the USA or multinational companies. Spain has a smaller scope so it makes sense that the offers are smaller and their conditions worse, but also it usually they ask for less requirements.

About the languages, we all agree that there is an absolute dominance of the English, since it's the international standard language for communication, and it is asked even in positions inside Spain.

About the key words, some groups had encountered the most Python and some others C++, but it's clear by our results that those two technologies are the most commonly found by a far stretch. Some groups pointed they have seen many times key words such as MPI and ARM while we did not find them much, but on the other hand we found many times words like Linux and CUDA while they did not highlighted them.

Concluding, the professor talked about the FPGA technology and how we can find many offers in Spain if we have knowledge and experience about this. Also he introduced us to the Barcelona Supercomputing Center, that offers many job positions in the supercomputing field here in Spain.

