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Implementing the ACO Algorithm and Fog Nodes for Efficient Resource and Energy Allocation in Cloud Computing

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Abstract
Even if it takes place inside the context of a service, the user is the one who is accountable for the trip that the information takes to and from the cloud. The cloud administrator, on the other hand, is the one who is responsible for supplying the required computing resources. According to the findings of the research, this is still the case in spite of the fact that the trip takes place. We suggest using swarm intelligence in conjunction with fog nodes in order to transfer data to and from the cloud via the path that is determined to be the most efficient. This is due to the fact that the process of resource providing calls for a strategy that consists of numerous levels, with each layer representing a different type of resource that may be delivered in a number of different ways.
Keywords: ACO, Swarm intelligence, Fog nodes, Cloud computing

1. Introduction

As a direct consequence of the quickening pace at which ubiquitous networking technology and scattered smart devices are being created, new network applications are now being developed. The Internet of Things, smart cities, smart grids, augmented and virtual reality, and applications that are not tied to automobiles are some examples of these new network applications. Computing on the cloud is required in order for these apps to function properly. The term "cloud computing" refers to the use of an expansive network of virtual or physical computers that are linked to one another. manned. It is a fact that is well acknowledged that the infrastructure that supports global communications is always undergoing modification. As a result of this, a growing number of different kinds of tools and applications are being created to simplify and improve the lives of consumers as well as the operations of businesses. As a direct consequence of this unceasing process of development, completely novel modes of communication are continually becoming available to users. One example of such an option would be to consider the potential of transferring some programs to servers that are situated farther away from the user. In a setting such as this one, it's possible that the concept of "computing in the cloud" will become more widespread. A network of distant computers, sometimes known as "servers," that work together to deliver a range of services to the individuals who use the system's end products. This network is frequently referred to as "the cloud." Every single computer network has its very own one-of-a-kind collection of problems, and it is imperative that each and every one of these problems be handled with the utmost caution. One of these challenges is the issue of how to limit the usage of the system while simultaneously increasing its efficiency in order to save expenses while keeping the same degree of communication speed:

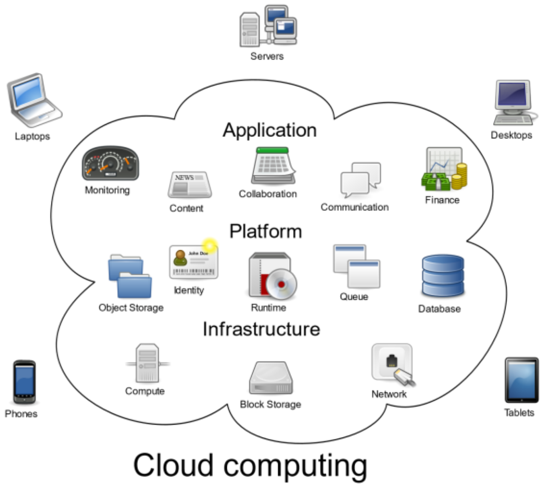

Figure 1: Standard operating procedure for cloud computing (Ren et al., 2018)

2. Cloud-Fog Computing

Computing in the cloud, also known as fog computing, is a method that offers network access to virtually limitless shared computer resources very instantly from any location on the earth. Because these resources are instantly accessible, there is no need for any kind of administration or human engagement in the process. An establishment provides many different kinds of services to its customers. As a result of this, it is required to organize and classify

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these services in accordance with the qualities that they include. The availability of services and the simplicity of access to cloud-based fog computing are the two methods of classification that come up most often over the course of the investigation. the many categories of service that are available to be obtained. The following taxonomy of the many different kinds of services that may be supplied using cloud-based and fog computing has been amended and revised by Musa (2019).

A. The supply of infrastructure capabilities to end users in the form of a service is what's known as "infrastructure as a service." With this strategy, companies take on the role of service providers, providing clients with access to their full complement of computing capabilities in exchange for a per-use payment that is equal to the amount of time spent using those resources.
B. PaaS is an abbreviation for "platform as a service," which describes the supply of a cloud-based platform that may be used to construct, deploy, manage, and maintain software applications throughout their respective life cycles. To put it another way, platform as a service is merely another name for cloud computing.
C. The software as a service (SaaS) paradigm is one in which the customer accesses services through the internet rather than the developer creating customized software for each individual user. Paying for applications that fall under this category may be done in a number of different ways, the most common of which being monthly subscriptions and pay-per-user models.
D. "Database as a service," sometimes abbreviated as "DaaS," is the practice of providing customers with access to and storage of their data online. Adopt a design that is able to accommodate a large number of users and keeps all data pertaining to users in a single database table.

3. Resource Allocation Using ACO Algorithm

Shorthand for "allocation of costs issues," or ACOs for short, these types of optimization challenges fall into a particular category. The process of finding how to schedule personnel to do a certain activity is an example of the labor force issue, which is also referred to as the WFP in some circles. A unique personnel quadrant will be built based on shift start times, the number of workers allocated to each shift, the total number of employees, and the number of rest days awarded to each employee. This quadrant will be used to decide who is scheduled to work when. Each of these factors will influence the creation of the quadrant in its own unique manner. It is essential for us to lower our payroll expenses as much as possible while yet maintaining a high level of shift productivity. This article will provide several examples of various resource allocation issues in order to illustrate the core of a variety of different concerns associated with resource allocation. When it comes to delegating resources to various sorts of responsibilities, there are a lot of different options available. It is important to note that not all of these methods are created equal; thus, it is necessary to determine which method is the most successful. It is a challenging activity that calls for the use of certain tactics in order to discover the reaction that will result in the greatest number of favorable consequences. Because of the importance of these combinatorial optimization challenges in the real world, A substantial amount of time and effort has been invested in researching and creating a vast array of distinct tactics. These algorithms were designed to offer answers to a variety of problems. The exact algorithms and the approximation algorithms are the two categories that may be used to classify these algorithms. When applied to a particular instance of an OC problem, specialized algorithms are guaranteed to identify the best possible solution within a predetermined length of time. The fact that many OC problems can't be solved in polynomial time makes them NP-hard problems. Problems classified as NP-hard are notoriously difficult to resolve.

4. Proposed System

The Traveling Salesman Problem (TSP) served as the initial source of motivation for the development of the Automatic Collaborative Optimization (ACO) algorithm. This is a problem in which a merchant is required to visit a number of customers who are located in different places, while also taking the shortest possible path to leave their home base, visit each customer only once, and then return. The output of metaheuristics may be increased by using the 2-opt heuristic as a kind of local search. A parametric function may also be used to decide the path that the ants will travel, which is another way in which the usefulness of the current system can be enhanced. They employ candidate lists to help narrow down the pool of potential replies and figure out which ones have the best chance of being selected. We are only aware of the Ant System as an algorithm that has ever made use of candidate lists; we are not aware of any other algorithms that have ever done so. improved upon earlier implementations of CVRP by making use of a different ACO algorithm; These updated versions take use of the "savings" achievable when clients are grouped together on the same route as opposed to being routed on separate routes. As part of this upgrade, the Ant System features a brand-new algorithmic phase, which adds to the program's overall enhancement. This step, also known as "raising the attractiveness of the candidate list," entails rating prospective target nodes according to how desirable they are. The term "increasing the attractiveness of the candidate list" describes this stage. After the current cycle has completed its full iteration, we will be able to go on to the next one. In addition to that, the 2-opt heuristic is used whenever the local search is being carried out. When a substantial number of consumers are being served by each route, it appears appropriate to apply the Lin and Kernighan heuristics, which are widely employed in ACO applications to solve CVRP, when a considerable number of customers are being provided by the 2-opt heuristic. This is because the Lin and Kernighan heuristics were developed by Lin and Kernighan. It is essential to improve the solutions that the ants have evolved in the past to the problem of the dispersal of the pheromones in order to make the whole process more successful. This will guarantee that the pheromones are administered in the correct manner. It should not come as a surprise to anyone that the implementation of local search procedures of this kind would result in the technique converging more quickly when compared to the number of iterations that were required in the past; rather, this outcome should not come as a result of any kind of surprise at all. It is essential to take into consideration the fact that the amount of time needed to do calculations will increase with each iteration in order to determine whether or not linear programming can be used and whether or not it can be used to solve issues. The purpose of this study is not to identify the most efficient method for resolving VRPs; rather, it is to demonstrate the possibility of adding the ILP into a regional search strategy as a potential solution to the problem. Both the more traditional TSP model and the General Branch & Bound technique, both of which are included in the GLPK package and are both available under the GNU license, will be used to solve the TSP problem. In the event that it is determined that the suggested strategy has a good chance of being carried out successfully, it is possible, at a later time, to make modifications to these three aspects of the project.

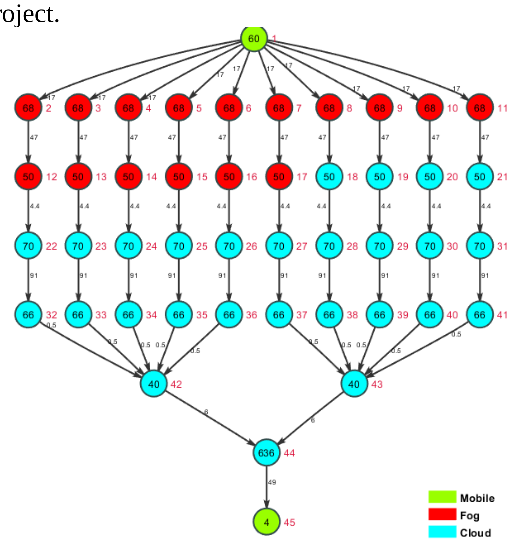

Figure 2: Impasse in the network without ACO optimization

The application of an offset in such a way that it is aligned in some way with the initial time measurement is the first of these fundamental methods. When a request is not being actively processed by the server, it is our goal to assign it to another request so that it can continue to be utilized. The server's versatility as a multitasker will increase as a result of this change. It is possible, as a result of the time displacement that occurs between requests, to reallocate some of the time that was initially set aside for one request to another request without having any impact on either of the original requests. It wouldn't take long for the overlap to start affecting it once it starts spanning the task time of the other request, which is when it would start having an effect.

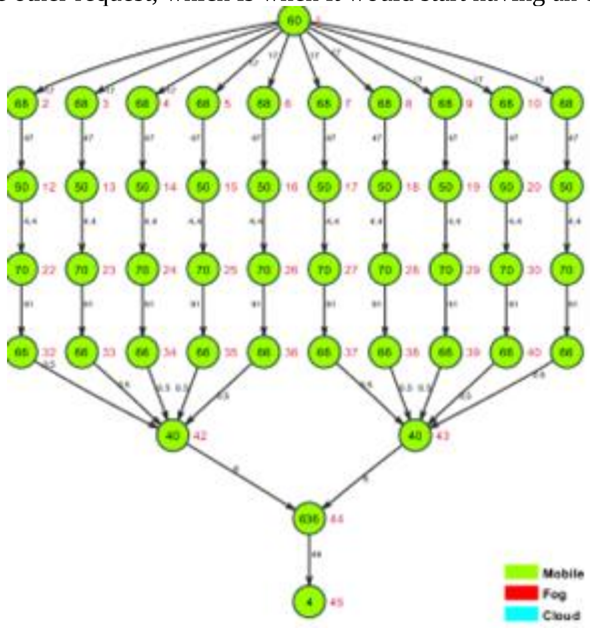

Figure 3: Network allocation using ACO optimization

5. Conclusion

The results of this study were able to identify the benefits and characteristics of a fog computing scenario that was optimized for ACO. The benefits of a distributed architecture are achieved in a number of different areas, including the outcomes of low-latency use cases. It is very essential for the operation of cloud-based infrastructure that the underlying network maintains its integrity. It may be possible for applications to become more streamlined and less dependent on cloud entities as a result of less data having to leave the local network of a device. A wide variety of hardware configurations, both in the cloud and in the local structure of the fog, may be examined as potential future research options relevant to this problem. This might be done either in the cloud or locally. Some of the most important characteristics that might be considered for inclusion in the evaluation include things like reliability, availability, level of privacy, and the cost to construct and maintain the related structures. The cost of constructing and maintaining the linked buildings could also be accounted for in the analysis.

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