Research on Resources Based on Hypotheses Grid Computing Scheduling

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ABSTRACT

When it comes to grid computing, resource scheduling is all about efficiently matching workloads with resources. Grid computing's varied environment makes resource scheduling a challenging undertaking. At its heart, Grid resource management systems are Scheduling. The effective scheduling of resources in Grid computing has been the subject of several research proposals. A overview of Grid computing resource scheduling strategies based on heuristics is described in this work. These systems are mainly categorized into two groups: meta-heuristics and hyper-heuristics. With varying restrictions, we compared all of the approaches.

Keywords: Metaheuristics; Hyperheuristics; Grid Computing

Introduction

Grid computing is becoming a key component of network technology that can meet the power needs of massive computational workloads. The idea behind the grid is to put all the unused network resources to good use. Grids can be useful for solving intense issues in many different scientific fields. An expert set of methods is required to deal with the myriad resource management issues that crop up as the grid expands. The assignment of tasks to appropriate grid resources is an NP-complete issue due to the heterogeneity and dynamic nature of these resources. It is recommended to use heuristic approaches for solving NP complete issues. Metaheuristics and hyper heuristics are the two primary types of heuristics used in grid computing. Grid has several problems, such as managing information, scheduling jobs, ensuring resources are available, and dealing with security-related concerns [1–15].

Several heuristic methods that are applicable to Grid scheduling are covered in this work. Both meta heuristics and hyper heuristics are key techniques. As an issue-specific approach to solution, metaheuristics necessitate familiarity with the problem area and relevant prior experience. In order to provide the best answer for every given issue, hyper heuristics are designed to be generic optimization approaches. Instead of candidate solutions, they work on the heuristic search space. When it comes to scheduling resources, both systems provide excellent ideal solutions.

The scheduling of resources in Grid computing, which is the second part of the article. Section 3 provides a taxonomy of Grid computing heuristic methods, Section 4 analyses how well they function, and Section 5 brings the study to a close.

Scheduling of Resources

Resource scheduling is the meat and potatoes of grid management systems when it comes to managing issues effectively. Being a diverse environment, the Grid system requires efficient algorithms to schedule resources in a way that completes job execution appropriately. In the

event of a failure, these resources may be able to enter or exit the system autonomously and sit idle for a while. To build a schedule that adapts to environmental heterogeneity and dynamism while attempting to reduce overall task execution time, a scheduling method is required. Resource identification, resource selection, and task execution are the three fundamental processes in mapping resources to jobs [16–28].

(1) Finding the System's Available Resources: This involves looking for the system's resources that have not been assigned yet.

Second, while allocating resources, it is necessary to choose the best one according to a heuristic algorithm that will schedule the tasks in the queue.

Thirdly, carrying out the work entails assigning the chosen resource to the assignment and then carrying it out [16-32].

Grid resource management systems essentially involve assigning tasks to the resources that are available for use in making those tasks. In order to meet the user's expectations, this procedure involves searching across many administrative domains to utilize the resources available from the Grid infrastructure. There are two stages to grid scheduling. The first step is to determine which resources are needed based on user requests. The second step is to assign jobs to those resources, which further ensures that QoS parameters are nearly optimally satisfied. Grid job scheduling can be done with or without time characteristics, depending on the resource broker's decision-making policies. In the latter case, time characteristics derived from prediction mechanisms are used. After receiving offers from resource providers according to their local policies, the grid resource broker is then tasked with finding those resources, binding user applications to them, allocating jobs to those resources, starting computational adaptive changes to those resources, and finally, showing the user the grid as a bound resource.

Optimization via Metaheuristics

The Resources management system revolves around scheduling. A challenge of NP completeness is the grid scheduling. Grid scheduling difficulties are solved using a variety of metaheuristic approaches [33-48].

Particle Swarm Optimization

Among the most recent evolutionary optimization methods that draw inspiration from nature is Particle Swarm Optimization (PSO). Swarm intelligence is the basis of this resilient stochastic optimization method. It has been effectively used as a notion for social involvement in issue solving and has greater global searching capabilities. In comparison to genetic algorithms and simulated algorithms, it also contains less parameters. The PSO technique is also effective for the vast majority of global optimization issues. When dealing with severely distorted characters, the PSO method is used to tackle the grid scheduling problem. A swarm of agents, or particles, navigates the search space in pursuit of the optimal solution; this is the core principle of PSO. Imagine an N-dimensional space filled with points that adapt their movement based on their own and other particles' past movements. In this space, each particle keeps track of its own coordinates, which correspond to the best fitness

value it has achieved thus far; this value is called pbest. The heuristic also finds the best value, which is the gbest, which is the best value that any particle in the vicinity of that particle has attained so far. At each time step, the fundamental idea of PSO is to randomly accelerate the weight of each particle toward its pbest and gbest positions.

Based on the available information, such as the current velocities, positions, distance between the heuristic's current position and its pbest, and distance between the heuristic's current position and its gbest, the particles attempt to modify their the group's gbest is defined as [49–62].

With PSO, every particle remains a part of the population as the run progresses. Therefore, PSO is useful for quickly and easily obtaining the best options. The PSO lacks a selection operation, distinguishing it from genetic algorithms and other evolutionary systems. One algorithm that doesn't use the SOS principle is PSO.

Genomic Method

When it comes to optimization and search space issues, a genetic algorithm (GA) is a search strategy that computers utilize to find genuine or approximate answers. One kind of search heuristic is the genetic algorithm. A subset of evolutionary algorithms, genetic algorithms draw on principles from evolutionary biology, including natural selection, mutation, inheritance, and recombination to determine the optimal set of chromosomes to utilize. Of the several metaheuristics used to solve scheduling issues, genetic algorithms have shown to be the most effective and widely used. Based on the natural progression of genes in living things, genetic algorithms are adaptable approaches to optimization issues. A genetic algorithm is a kind of algorithm that may be used to solve real-world issues [63–88]. Much effort has gone into developing genetic algorithms for grid scheduling, with the goal of producing optimum schedules. The genetic algorithm makes advantage of the natural language of behavior. In their working environment, there is a population of people, each of whom represents a potential solution, or partial solution, to a problem; for example, a population of 1000 chromosomes. A fitness value is assigned to each individual chromosome based on how optimum it is at solving the given task. By allowing cross-breeding, the population ensures that the fittest individuals have the chance to procreate. In scientific parlance, this phenomenon is called mutation and cross-over. The basic outline of a genetic algorithm is as follows.

Establishing a baseline population; Assessing

The stopping requirements have not been reached yet.

Evaluation, Selection, Crossover, and Mutation

New people are created through the mutation process; these children acquire certain traits from their parents. This process, which involves mating individuals with higher fitness values, involves exploring the majority of the available search space in the environment. If the genetic algorithm is well-designed, the population will come together to find the best solution to the problem. The algorithm's reproduction phase enhances the genetic algorithm's performance. In which, the chromosomes of the chosen parents are recombined utilizing

mechanisms of mutation and crossover. Crossover refers to the process of randomly dividing a pair of chromosomes into two sets, one with the "head" and the other with "tail" halves. A new chromosome is generated by exchanging the tail parts. Therefore, the two progeny inherit a combination of genes from both parents, as well as the mutation process, which alters genes with a less-than-random probability. Because of this, finding the best option becomes considerably easier [89-108].

Tabu Search in Genetic Algorithms

It combines elements of both Genetic Algorithm and Tabu Search, two metaheuristics methodologies. The GA-TS hybrid algorithm keeps the tabu list up to date. Metaheuristic neighborhood search with overriding local optimality is the basis of this approach. It guides the process of choosing neighbors. This hybrid heuristic attempts to mimic human memory processes in a deterministic manner, in contrast to Simulated Annealing. The memory stores the previously visited solutions, and the search is based on a list of the fitness values of the neighbors, utilizing basic yet effective data structures. Thus, the presence or absence of a chromosome in the tabu list is verified whenever a new chromosome is generated by population-level mutation. No matter how good it is in comparison to the existing answer, it gets rejected if it is there. After adding the new solution to the tabu list and checking its quality, if it is not already there, it is added. We will accept it if its quality is greater than the present solution. In order to decrease run time, the hybrid guarantees that previously visited solutions are not revisited. Since it is both adaptive and sequential, it aids in finding the best solution [109–118].

Analytical shortcuts

Instead than focusing on fixing a single problem, hyper heuristics aims to construct systems that can manage classes of problems. Efficiently solving search space issues is the goal of hyper-heuristics, a type of heuristic search approach. Each heuristic has its advantages and disadvantages, and there may be more than one heuristic to pick from when addressing an issue. The goal is to come up with algorithms all at once by merging the good and bad characteristics of existing heuristics in the search field. One may find both high-level methodologies and sets of low-level heuristics in a typical design of a hyperheuristic framework. The high-level technique takes an instance of the issue and, based on the problem state, decides which low-level heuristic to apply at any given time.

Metaheuristics are a kind of issue-specific technique to solving problems; using them effectively calls for extensive expertise of the problem domain and its attributes, as well as meticulous parameter adjustment. In exchange for theoretical simplicity or improved computer efficiency, heuristics are believed to sacrifice accuracy and precision. Given that many metaheuristics in the search space environment have their own set of pros and cons, it only makes sense to look for ways to combine them such that their strengths may compensate for each other's shortcomings [119-124]. This may be illustrated in a more basic form as follows:

use heuristic1 on p if issue type(p) is equal to p1.

then execute heuristic2 on p if issue type(p) is equal to p2.

in any other case when

At the other end of the spectrum from the previous method would be an algorithm with endless switch statements that lists every finite problem and uses the best known heuristics for each one. This is obviously not the greatest way to solve problems. It is more effective to use many heuristics at different stages of the solution process, each of which improves performance under the specific conditions of the issue. An approach to selecting a heuristic from a pool of low-level heuristics is known as a hyper-heuristic. You may think of it as a supervisor that oversees the process of building a solution or timetable by controlling the selection of a local search neighborhood. A low-level heuristic, or local search neighbor, is an easy-to-implement rule or strategy that often results in a little adjustment to the scheduling procedure. These strategies might be as complex as metaheuristics or as basic as hyper-heuristics.

Two steps, heuristic selection and movement acceptance, make up a single hyperheuristic method iteration. These low-level heuristics are picked at random by the simple selection techniques. At each iteration, greedy hyperheuristics chooses the heuristic that performs the best. A choice function is used to keep track of each heuristic's prior performance and make a choice. There are two possible types of movement acceptance: deterministic and nondeterministic. It is possible to use the huge deluge method as a nondeterministic acceptance criterion. An improved version of the Great Deluge algorithm [Gunter (1993)] forms the basis of the employed hyperheuristic method. When choosing a heuristic, the greedy selection heuristic is employed. Presented here is the fundamental idea behind the Extended Great Deluge Hyper-heuristic Algorithm.

Procedure 1: Setting Up

1.Set up the population.

2.N is the number of iterations set;

3.Determining the fitness function f(s)

4.Beginning point B0 = f(s)

5.Parameter B must be specified.

6.Fix the value of i to 1;

In Step 2, when the condition is not stopped, process the ith chromosome.

1.Applying the selection heuristic, choose the candidate solution s*.

2.Find s*'s fitness function.

3.It is valid to accept s* if f(s*) < B, and f(s) = f(s*).

4.(B) is equal to (B-Δ B).

At the beginning of the process, we set the fitness function f(so) to level B. ΔB gradually reduces this with each cycle. The algorithm's execution is reliant on the total number of iterations, starting fitness function, and the parameter ΔB being chosen.

The main distinction between hyper-heuristics and metaheuristics is that hyper-heuristics keep searching within a space of heuristics, whereas most metaheuristic implementations seek within a space of issue solutions. So, instead of attempting to solve a problem directly, hyper-heuristics seek out the appropriate approach or sequence of heuristics for a particular scenario. Also, instead than focusing on fixing a specific problem, try to find a universally applicable technique. Based on the properties of the solution space region being explored, the hyperheuristic determines which low-level heuristic approach should be employed at every particular occurrence [125-207]. This indicates that the hyperheuristic does not actively seek for a more optimal solution. Instead, it chooses the most promising basic low-level heuristic at each phase of the solution process, with the potential to enhance the result. Therefore, the Hyperheuristic is an innovative method that combines a straightforward scheduling procedure with high-level methodology.

Assessment of Achievement

A number of test scenarios were run through the scheduling experiment in order to assess the heuristics. To ensure the statistical accuracy, we have utilized an average of fifty runs. A graphical representation of the findings and performance of the scheduling experiments is provided for many test scenarios. Figures 2 and 3 demonstrate a comparison of the performance of the genetic algorithm, hyper-heuristic, GA-TS, and particle swarm optimization across fifty runs of the sample instances.

Conclusion

One of the most difficult aspects of Grid computing is scheduling, which has arisen as a solution to problems on a vast scale in the fields of science, engineering, and other related fields. While meta-heuristics perform admirably in a Grid computing setting, they struggle to deliver satisfactory results when faced with a greater volume of workloads in a heterogeneous setting. When these factors and the outcomes of the simulations are taken into account, it becomes clear that the hyperheuristic offers a superior, less heterogeneous, and almost ideal solution to the scheduling challenges that arise in a Grid. In this research, we try to schedule jobs in a grid environment utilizing hyper heuristics on top of meta heuristics developed using existing heuristics, and these heuristics include Genetic Algorithm, Particle Swarm Optimization, and a hybrid of Genetic and Tabu Search. Experimental results demonstrate that, across all test situations, the hyper heuristic based on hybrid metaheuristics outperforms the individual hybrid heuristics. The computing effort required by global optimization techniques is substantial. Therefore, in a dynamic setting such as Grid computing, the most important thing is to build schedules as quickly as possible, which implies that scheduling should have a minimal makespan. With the advent of the hyperheuristic, grid computing scheduling problems may now be more easily and effectively handled. For this reason, Grid computing is the most practical option.

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