

A Survey on Workflow Scheduling in Cloud Computing

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ABSTRACT: In cloud computing users are charged based on how they use resources. Users pay price on demand for the computational resources. Pay-as-per-use pricing strategy is used for the users to get the resources. Various algorithms are used for the scheduling of workflow previously. But these algorithms are applied on the grid computing. But nowadays scheduling algorithm are directly applied on cloud environments. By using evolutionary multi-objective scheduling makespan and cost will get reduce. Evolutionary multi-objective scheduling better solution than other algorithms which minimizes both makespan and cost.

I. INTRODUCTION

Cloud computing has become popular and reached maturity capable of providing the promising platforms for hosting large-scale programs. In a Cloud model, on-demand computational resources, e.g., networks, storage and servers, can be allocated from a shared resource pool with minimal management or interaction. Infrastructure as a Service (IaaS) is one of the most common Cloud service models, which provides customers with the abilities to provision or release pre-configured Virtual Machines (VMs) from a Cloud infrastructure. Using the VMs, which are called instances in IaaS, customers can access to almost unlimited number of computational resources while remarkably lowering the Total Cost of Ownership (TCO) for computing tasks. Usually, these services are provided under a Services Level Agreement (SLA) which defines the Quality of Services (QoS). Hereafter, the IaaS service provider can charge customers by their required QoS and the duration of use. Workflow is a common model to describe scientific applications, formed by a number of tasks and the control or data dependencies between the tasks.

Extensive experiments on real world workflows and randomly generated workflows show that the schedules produced by our evolutionary algorithm present more stability on most of the workflows with the instance-based IaaS computing and pricing models. The results also show that our algorithm can achieve significantly better solutions than existing state-of-the-art QoS optimization scheduling algorithms in most cases. The conducted experiments are based on the on-demand instance types of Amazon EC2; however, the proposed algorithm are easy to be extended to the resources and pricing models of other IaaS services.

The multi-objective scheduling algorithms are classified into QoS constrained algorithms and QoS optimization algorithms. In practice, most algorithms require QoS constraints to convert this problem into a simpler single-objective optimization problem. LOSS and GAIN are two budget-constrained algorithms, which start from existing schedules and keep trying reassigning each task to another processor until the cost matches or exceeds the budget. Budget-constrained Heterogeneous Earliest Finish Time (BHEFT) is an extended variant of HEFT, which considers the best budget reservations in each assignment. Recent studies include Heterogeneous Budget Constrained Scheduling (HBCS), which also starts from existing schedules and defines a Cost Coefficient to adjust the ratio between available budget and the cheapest possibility. Also, a workflow execution planning approach using Multi-Objective Differential Evolution (MODE) is proposed in, to generate tradeoff schedules according to two QoS requirements time and cost.

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There have been consensus on benefits of using Cloud to run workflows. Some Grid workflow management systems, like Pegasus and ASKALON, are starting to support executing workflows on Cloud platforms. Juveet found that Cloud is much easier to set up and use, more predictable, capable of giving more uniform performance and incurring less failure than Grid. Workflow scheduling problem, which is known to be NP-complete, is to find proper schemes of assigning tasks to processors or services in a multi-processor environment. There has been much work on the workflow scheduling problem in heterogeneous computing environments. Heterogeneous Earliest-Finish-Time (HEFT) and Critical-Path-on-a-Processor (CPOP) are two best-known list based heuristics addressing the performance-effective workflow scheduling problem, which are widely used in popular workflow management tools. The list-based heuristics schedule tasks to the known-best processors in the order of priority queues. Although the classical algorithms aim to minimize only finish time, recent studies begin to consider both total monetary cost and execution make span since it is common to rent computational resources from commercial infrastructures such as Grid and Cloud nowadays.

II. RELATED WORK

Juan J. Durillo et al.[1] proposed MOHEFT, a Pareto-based record scheduling heuristic that gives the user with a set of transaction best solution from which the one that better, the user necessities can be physically elected. Demonstration of the potential of method for multi-objective workflow scheduling on the commercial Amazon EC2 Cloud. The author compare the quality of the MOHEFT tradeoff solutions with two state-of-the-art approaches using dissimilar synthetic and real-world workflows: the classical HEFT algorithm for single-objective scheduling and the SPEA2* genetic algorithm used in multi-objective optimization problems.

Sen Su et al.[2] proposed wide arithmetical experiments on big DAGs generated at casual as well as in real applications. Hybrid is used to denote the algorithm that first uses POSH and then uses STSH to produce a scheduling plan. Author carryout broad numerical experiments to evaluate and compare the recital of Hybrid, and HEFT on huge DAGs generated at arbitrary and on real-life applications. The imitation results show that our algorithm can substantially decrease monetary costs while producing make span as good as the well-known task-scheduling algorithm can provide. DAG can be executed by multiple VMs simultaneously. The first strategy enthusiastically maps tasks to the most cost-efficient VMs based on the concept of Pareto dominance. The second strategy, a match to the first strategy, reduce the monetary costs of non-critical tasks.

Saeid Abrishami et al.[3] proposed the PCP algorithm for the Cloud environment and suggest two workflow scheduling algorithms: a one-phase algorithm which is called IaaS Cloud fractional Critical Paths (IC-PCP), and a two-phase algorithm which is called IaaS Cloud Partial Critical Paths with deadline Distribution (IC-PCPD2). IC-PCP schedules the workflow in one phase by scheduling each partial critical path on a single instance of a calculation service, while IC-PCPD2 is a two-phase algorithm which first distributes the overall deadline on the workflow tasks, and then schedules every task depend on its sub deadline. There are three significant differences between the current commercial Clouds and the utility Grid model for which author devised the PCP algorithm. The first difference is the on-demand(dynamic) resource provisioning feature of the Clouds, which enables the scheduling algorithm to determine the type and the amount of required resources, while in utility Grids, there are predetermined and limited resources with restricted available time slots. This property gives the illusion of unlimited resources to the Cloud users. The second distinction is the homogeneous bandwidth among services of a Cloud provider, versus the heterogeneous bandwidth between service providers in the utility Grids. The third (and most important) difference is the pay-as-you-go pricing model of current commercial Clouds which charges users based on the number of the time intervals that they have used. Since the time interval is usually long (e.g., one hour in Amazon EC2) and the user is completely charged for the last time interval even if he uses only a small fraction of it, the scheduling algorithm should try to utilize the last intervalas much as possible. Considering these differences, author adapt the PCP algorithm and propose two novel workflow scheduling algorithms for IaaS Clouds, which are called the IaaS Cloud-Partial Critical Paths (IC-PCP) and the IaaS Cloud-Partial Critical Path with Deadline Distribution (IC-PCPD2).

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G. Juve et al.[4] have described experience modeling the periodogram function as a scientific workflow via Pegasus, and deploy it on the Future Grid scientific cloud tested the Amazon EC2 profitable cloud, and the Open discipline Grid. The main advantages of EC2 for the periodogram workflow were its scale and stability. While it is achievable for Amazon to sprint of accessible resources, such an event is strange in our experience and we were capable to stipulation all the resources we essential with no trouble The price of by EC2 depend on the quantity of computation, storage, and data transfer required. EC2 and FutureGrid provide very similar platforms in terms of scientific features, and they both require an important amount of system administration to a group and keep VM descriptions and to deploy applications. FutureGrid gives an important number of resources to explore cloud computing in a technical context, however, the whole number of resources presented to the regular user is more limited than EC2 or OSG, requiring the utilize of multiple clusters within FutureGrid for larger experiments. We evaluate and dissimilarity the infrastructures in terms of system, usability, price, resource openness and performance. It useful to use provisioning tools such as Wrangler and Glide in WMS to assist us in deploying our application.

M. Zhu et al.[5] projected a two-step workflow scheduling algorithm to diminish the cloud transparency within a user-specified execution time bound. The wide replication consequences illustrate that our progress constantly achieves inferior computing transparency or higher resource exploitation than accessible methods within the execution time bound. Improves resource consumption for elevated throughput. Delay-constrained optimization problem to exploit resource use. In the initial step, modules are mapped from the first level to the last level in instruct to identify best mapping strategy to decrease the execution time. If the final finish time is before then the latest finish time particular by the user, the extra allowed time delay is worn to relax the mapping of modules to decrease the cost of VM setup and shutdown and the idle time. A backward remapping procedure for modules from the final layer toward the first layer is conducted to cut down the overhead. One strategy make use of the allocable volume of a VM to open the window for more modules to reuse it.

W.N. Chen et al.[6] proposed an ant colony optimization (ACO) algorithm to plan large scale workflows with different QoS parameters. This algorithm enables users to identify their QoS preferences describe the slightest QoS thresholds for a certain application. The aim of this algorithm is to find a result that meets all QoS constraint and optimizes the user-preferred QoS constraint. An adaptive scheme to manage these heuristics. The scheme allows synthetic ants to use the pheromone to choose heuristics when they are constructing solution schedules. The algorithm is tested on ten workflow applications of different scales. Experimental outcome discloses that the algorithm is efficient. With the development of computational grids, more and more GSPs emerge in grid environments and the scale of workflow applications becomes larger and larger. Moreover, users may set up a set of QoS constraints for the workflow application and have

their own preferences. A good scheduler should find a solution that satisfies the user-defined constraints and optimizes the user preferred QoS parameters as well. In this case, traditional workflow scheduling strategies fail to work. First, most of the existing

algorithms can only deal with one QoS parameter and neglect all the others. Second, in large-scale applications, the performance of traditional deterministic algorithms for workflow scheduling

decreases quickly. In order to solve this intractable scheduling problem, this paper applies an ant colony optimization (ACO) approach. ACO is a metaheuristic proposed by Dorigo in the light of the foraging behavior of ants. It works by simulating the pheromone-depositing and pheromone-following behavior of ants, and has been successfully applied to various intractable combinatorial optimization problems. The primary advantage of ACO for the workflow scheduling problem is that ACO manages to make full use of the instance-based heuristic information, which is found to be important for scheduling problems. Author focuses on large-scale workflow scheduling problems in a global grid environment with various QoS parameters. In our model, three of the basic QoS parameters are addressed: reliability, time, and cost. These parameters are important for a grid application and their characteristics are quite different. A user may submit a workflow application and specify the basic

QoS demands: lower bound of reliability, deadline, and budget. Additionally, the user may prefer to optimize one of the QoS parameters. So the objective of the proposed ACO algorithm is to find a feasible schedule that satisfies all user-defined QoS parameters as well as optimizes the user-preferred QoS parameter.

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Marek Wieczorek et al.[7] proposed numerous narrative taxonomies of the difficulty, in view of five facets: workflow model, scheduling criteria, scheduling procedure, resource model, and task model. Analyzed the complexity of multi-criteria Grid workflow scheduling. Based on a careful selection of the relevant work in this area and on our own experience, the system identified the main aspects of the difficulty that have to be taken into reflection when the development of workflows on the Grid. The author did a survey of the existing related work, and classify it according to the proposed taxonomies, identifying the mainly frequent use cases and the areas that have not been sufficiently explored up till now. The goal of the work, is to analyze the general problem of Grid workflow scheduling, mostly for multiple scheduling criteria, by reviewing the related work and discovering regularities and irregularities between different problem classes. Rather than focusing on the solutions applied, we try to recognize the complexity of the problem itself. In our research, we use the related work as a guideline, but, in addition, we also introduce ideas coming from our own experience and analysis. Another goal of this article is to propose a uniform terminology to describe different scheduling-related concepts. Our main contribution is a set of five novel taxonomies of the workflow scheduling problem that embrace five different facets (aspects): workflow model, scheduling criteria, scheduling process, resource model, and task model.

E. Deelman et al.[8] has studied the Pegasus structure that is able to be map difficult scientific workflows on disseminated resources. Pegasus helps users to differentiate the workflows at a conceptual level without needing to concern about the fundamentals of the goal finishing systems. Pegasus gives a choice to collect jobs together in cases where a numeral of small granularity jobs is destined for the same computational resource. evaluated the benefits of job clustering for an application with a relatively low computational granularity. It has exposed experimental grades of using Pegasus in the astronomy area in the circumstance of running on the TeraGrid. The domain posses challenge to the workflow mapping system. The Montage workflows are typically large, often with hundreds and thousands of tasks and the tasks have a short computational granularity which exposes the overheads of the effort compliance and scheduling systems. The workflow mapping problem can be defined as discovery a mapping of tasks to resources that minimizes the overall workflow execution time.

T. Fahringer et al.[9] has studied the ASKALON environment whose aim is to shorten the enlargement and effecting of workflow applications on the Grid. The author has demonstrated significant performance gains through two check pointing methods for saving and restoring the implementation of Grid workflows upon engine and application failures. The author have demonstrated significant performance gains through two check pointing methods for saving and restoring the implementation of Grid workflows upon engine and application failures. Grid infrastructure can provide massive calculate and information storage power, it is still an art to effectively harness the power of Grid computing.

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