ON DISTRIBUTED ALGORITHMS FOR COST-EFFICIENT DATA CENTER PLACEMENT IN CLOUD COMPUTING

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ABSTRACT — The increasing popularity of cloud computing has resulted in a proliferation of data centers. Effective placement of data centers improves network performance and minimizes clients' perceived latency. The problem of determining the optimal placement of data centers in a large network is a classical uncapacitated k-median problem. Traditional works have focused on centralized algorithms, which requires knowledge of the overall network topology and information about the customers' service demands. Moreover, centralized algorithms are computationally expensive and do not scale well with the size of the network. We propose a fully distributed algorithm with linear complexity to optimize the locations of data centers. The proposed algorithm utilizes an iterative two-step optimization approach. Specifically, in each iteration, it first partitions the whole network into k regions through a distributed partitioning algorithm; then within each region, it determines the local approximate optimal location through a distributed message-passing algorithm. When the underlying network is a tree topology, we show that the overall cost is monotonically decreasing between successive iterations and the proposed algorithm converges in a finite number of iterations. Extensive simulations on both synthetic and real Internet topologies show that the proposed algorithm achieves performance comparable with that of centralized algorithms that require global information and have higher computational complexity. Index Terms—Data centers placement, distributed algorithm, cloud computing, uncapacitated k-median problem.

INTRODUCTION Cloud computing is increasingly becoming the mechanism of choice to boost users' experience through timely delivery of data storage and computing capacity. To ensure prompt responses to clients' requests, a cloud computing service provider replicate its service on a large number of data centers deployed across the world. In this way, a client can be served by the nearest data center with a shorter perceived latency. This horizontal scaling approach is widely adopted by many big companies such as Google [1], Microsoft [2] and Amazon [3]. A natural problem associated with horizontal scaling is to determine the optimal placement of data centers in a large network in order to maximize network performance and minimize clients' perceived latency

Related Works

The uncapacitated k-median problem has attracted considerable amounts of attention. Initial results regarding the uncapacitated facility location and k-median problems are surveyed in the book [5]. A large number of works have focused on centralized approaches and have proposed approximations for the metric version (the distance measure is symmetric and satisfy the triangle inequality) of the k-median problem using various techniques: primal-dual schema with Lagrangian relaxation [6] [7], linear programming relaxation [8] and local search heuristics with swaps [9]. Motivated by increasing interests in content distribution networks (CDNs), a number of works studied the uncapacitated k-median problem in the context of CDN replica servers placement through centralized approaches. The first reference [10] considered a special case by assuming that the underlying topologies are trees and proposed a placement algorithm using the dynamic programming approach. For general Internet-like topologies, several centralized algorithms have been investigated in [11]. Simulations on both synthetic and real network topologies showed that a greedy algorithm with complexity O(n 2k) provides the performance closest to the optimal solution. The greedy algorithm is an iterative process, and the basic intuition is as follows. In the first iteration, for each site v among the n potential sites, evaluate the overall cost associated with choosing v as the replica server. Choose the one with the minimum cost as the first replica server. In the second iteration, determine the second replica server that provide the least cost together with the first replica server chosen in the first iteration.

IMPLEMENTATION

Admin

In this module, the Admin has to login by using valid user name and password. After login successful he can perform some operations such as view and authorize users, Adding Categories Sub-Categories, Adding Product Posts for by Selecting Category and Sub-Categories, Viewing Top- K Utility Item Set Keywords, Viewing all Products in terms of Construction of UP-Tree, Viewing all High Utility Item set Mining Products, Viewing All User Search History and Finding Top K Products Results in Chart.

Viewing and Authorizing Users

In this module, the admin views all users details and authorize them for login permission. User Details such as User Name, Address, Email Id and Mobile Number.

Add Categories, Sub-Categories and Product Posts

In this module, the admin adds Categories, Sub-Categories and Product Posts. The Product Posts are added by selecting particular category and Sub-Category and Product Details such as, Product Title, Price, Description and Image of that Product.

View all Products with Ranks and Comments

In this module, the admin can see all the uploaded products with product ranks and comments. The Product details contain Product title, description, price, and image.

The Comment details include commented user, their comment and the date of comment

View Top-K Utility Item Sets Keywords

In this module, the all keywords which are all used very frequently and less frequently will be displayed in a Rank (No. of times used) in a Top-K Order.

View all Products in terms of Construction of UP-Tree

In this, the admin can see all the products in a Tree Format. In this Tree, Firstly (On Top) Category then Sub-Category and lastly (at Bottom) Product Posts will be displayed.

View all high Utility Item Set Mining Products

In this, the top 5 Mining products will be displayed along with their details based on ranks. The Product details contain Product title, description, price, and images

Find Top K Products Results in Chart

In this, the top K number of products will be displayed based on top rank of products in a chart based on the value selected from the combo box.

User

In this module, there are n numbers of users are present. User should register before performing any operations. Once user registers, their details will be stored to the database. After registration successful, he has to login by using authorized user name and password. Once Login is successful user can perform some operations like viewing their profile details, searching for products based on product description, searching products and viewing them in a UP-Tree Format, Viewing Own Search History and Finding Top K Product Item Sets by selecting category and Top K Value.

Viewing Profile Details

In this module, the user can see their own profile details, such as their address, email, mobile number, profile Image.

Search Products

In this, the user search for products based on product description. The matched results will be displayed in two ways: Exact Matched and Related Products. Related Products are the products which are not exactly matched for user entered keyword and they are belong to the same category of exactly matched products category.

Search and View Products in UP-Tree Format

In this, the user search for products based on product description and the matched products will display in a UP-Tree Format. In a Tree there would be three layers. In a first top layer the Category name and in a second layer the Sub-Category Name and in a last layer the Product Title would be shown and user can see the product details by clicking on product name.

Finding Top K Item Sets

In this, the user finds Product Items Sets based on Category and Top k Value. The Result is the top K number of products from the Selected Category.

CONCLUSION

In this paper, we study the placement of data centers to improve network performance and minimize clients' perceived latency in the context of cloud computing, which is a classical NP-hard uncapacitated k-median theoretic problem. We first review the concept of centroidal Voronoi partition and show that it is a necessary condition for the optimal solution of the data center placement problem. We propose a fully distributed algorithm called the distributed

Lloyd's method with linear complexity which is built upon the classical Lloyd's method to determine the locations of data centers. The proposed DLM do not require knowledge of the global topology nor information Fig. 6. Total response time ratio of DLM to the greedy algorithm for Internet topologies. of the service demand. Each node only needs to communicate with its direct neighbors. DLM utilizes an iterative two-step optimization approach. Specifically, in each iteration, it first partitions the whole network into k Voronoi regions through a distributed partitioning algorithm; then within each region, it determines the local approximate optimal location through a distributed message-passing algorithm. When the underlying network is a tree topology, the overall cost is monotonically decreasing between successive iterations and the proposed algorithm converges in a finite number of iterations. Extensive simulations show that the proposed DLM achieves comparable performances as the centralized greedy algorithm on both synthetic and real world Internet networks, even the later require global information and has higher (O(n 2k)) computational complexity.

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