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A Survey of Methods for cloud workload analysis and cloud cost forecasting

Saurabh Desale[1], Varad Gujar[2], Atharva Raut[3], Satej Patil[4], Vitthal Gutte[5]

[1,2,3,4]B.tech Students, School of Computer Engineering and Technology, Dr.Vishwanath Karad MIT World Peace University Pune, India
[5]Assitant Professor, School of Computer Engineering and Technology, Dr.Vishwanath Karad MIT World Peace University Pune, India

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ABSTRACT

The area of cloud computing technology is booming rapidly and does see a bright future as seeing its current growth, as it provides various computing services that run on the same infrastructure. As seen cloud resources utilization increases and decreases based on particular time duration and services that the users select as per their preference provided by the infrastructure, a timely payment bill is generated based on user's consumption of cloud services. In current time forecasting/prediction technology is being used in almost all fields of work and can be also used in cloud computing technology to forecast cloud cost. This paper discusses the timeseries forecast modelling which also lists out some methods to perform timeseries forecasting which can be used to forecast cloud cost and describes cloud workload analysis and its workload categorization. Andpresents a detail proposed architecture which gives a flow of implementation that can result in forecasting the cloud cost.

Keywords*: Cloud Computing, Forecasting, *Workload analysis, cloud cost, Time Series model.

INTRODUCTION

The area cloud computing is growing with a very fast space as it is providing many online services on a single infrastructure. Many organizations and individual's user are using cloud services such as compute, storage,database,networking on a large scale as these cloud servers free up computing power and system memory of individual computers.

Cloud Computing

Cloud computing technology is opted by many service providers of the cloud such as google(gcp), Microsoft andamazon(aws) etc. These cloud service providers include all cloud services such as compute engines, storage, databases, operations, networking, tool, and technologies such as artificial intelligence and big data. All these services are present in a single infrastructure, where the users/organizations need to have basic requirement of having internet to use these cloud services. Utilization of these service follow 'pay per use' pricing model which means where one only pays for the number of resources and what types of services they have consumed. Some benefits of cloud computing[8] what make companies move towards cloud are expenditure can be reduced as service is based on "Pay Per Use", access to services can be done on any computer, it is highly scalable, no need for high end hardware requirement for a device and products can be quickly deployed.

Types of the services of thecloud computing[4]: The services of Cloud Computing fall into 3 main categories such as Software as a Service, Platform as a Service, Infrastructure as a Service .Allthese Services follow "Pay Per Use" model.

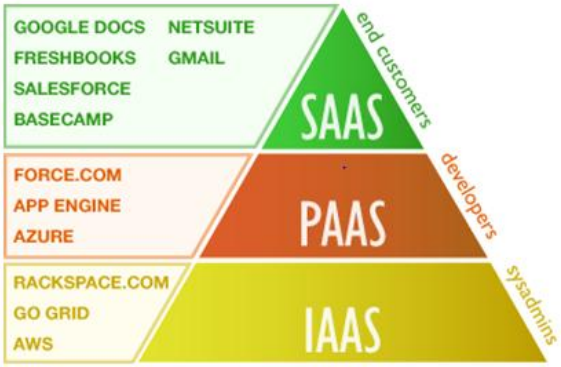

Fig-1 Types of services of the cloudcomputing[4]

***Software as a service (SaaS)*:** Software-as-a-service is the first layer of the service model as given in the above figure Fig-1. This service model provides on demand use of cloud services to the end users. This service model is a platform independent model and does not require any specific software to be installed on a local machine. All type of computing cloud resources and services are maintained and managed by the vendor. The services are accessed via web browsersor any kind of client application that are lightweight. Some of the popular service providers of cloud that make used of SaaS are google that provides an email service platform like Gmail, Drive. Some pros of this service model are that it can be accessible form any platform, Multi-Tenancy is allowed.

Platform as a Service (PaaS): Platform-as-a-service is the second layer of the service model as given in the figure Fig-1. The approach of this model is to provide a developer a platform having a runtime environment for development and deployment tools. In this model the end users must just manage the data and the application resources. All other resources required to run the platform are managed by the vendor. As this service model provides a run time and tools there is no need for the user to purchase expensive h/w and s/w. Some of the PaaS products and services are AWS Elastic Beanstalk, Heroku used for deployment and maintaining a web application.

Infrastructure as a service (IaaS): Infrastructure-as-a-service is a third layer of the service model as given in the above figure Fig-1. This service model provides a computational infrastructure to the end users. It follows a very flexible pattern where the end users are given full choice to add or customize the cloud-based resources or cloud services which include choice web servers, type of operating system, type of storage an end user want to opt for. Some pros for selecting IaaS service are it provides customizable infrastructure, enhanced scalability where dynamic workload is also supported. Security issues and network and delays in service are its cons for this service model.

Workload Analysis

Every workload has characteristics usage of hardware resources these hardware resources are GPU, CPU, main memory, and storage. Understanding what the usage pattern is by a given workload is called workload analysis. OLTP is an online transaction processing workload which can be typically seen in any e commerce-based deployments which is CPU as well as I/O intensive. SAP HANA which is an in-memory database and runs ERP workloads which is a memory intensive workload. A lot of gaming workload are CPU and GPU intensive. By understanding the workload characteristics, one is able to better plan the resources for that particular workload for efficient execution of that workload.

Cloud Workload: Cloud workload is function service or application which are processed by any remote server or an instance at any given time. A workload interaction is through the internet and it generally consist of users or applications. Databases, virtual machines, containers, web servers these all are considered as cloud workloads.

Cloud Workload Costing: Software, hardware, provision charges and application maintenance are the parameters for the costing of cloud workloads.

Categorization of Workloads [7]: There are in total mainly 4separate cloud computing workloads which are conditional towards different application are identified and described. The categorization is listed as follows:

- *Workload based on Networking* are these applications that define workload based on Networking.
- *Workloads based on CPU:* Scientific calculation with important data munching, encryption and decryption, compression and decompression are contained in the application.
- *Workloads based on Storage:* File serving, and data mining are contained in the application.
- *Workload based on Memory:* Memory caching servers, memory data servers are contained in the application.

Forecasting Modelling

Forecast modelling is a collection of statistical models that can be used to predict future outcomes and can be done using datasets, historical data available. In cloud computing the forecasting modelling can be used to predict the usage of computational resources as well as forecastingof future payment bill based on the cloud services and resource consumption which can be achieved using forecasting models.

Time Series Model: Time based series model comes in major types of the forecasting models that are used for forecasting, time series model can be useful when you have serially correlated data. This model makes use of historical data as to provide reliable forecasting. Times's series involves working on time durations (minutes, hours, days, months, years) based data. Time series forecasting can be accomplished by some of the time series forecasting methods are:

- Autoregression (AR)
- Moving Average (MA)
- Autoregressive Integrated Moving Average (ARIMA)
- Seasonal Autoregressive Integrated Moving Average (SARIMA)
- Vector Autoregression (VA)

REVIEW OF LITERATURE

Review Paper on Cloud Computing [1]

During the study of this review paper on cloud computing. This paper gives a detail information and explanation regarding important concepts such as components of cloud computing which act as a backbone of the domain of cloud computing the components are as follows 1) Client Computers, 2) Distributed Servers, 3) DataCentres. This paper also introduces the services of cloud computing which are SaaS, PaaS, IaaS which are the main 3 layers of cloud and these services provide different features individually. It also gives a basic information and knowledge of the 3 main types of cloud which are given as follows: 1) Public type ofcloud, 2) Privatetype of cloud, 3) Hybrid type ofcloud. Gap here that can be identified in this review paper is that the paper has not introduced the cloud cost pricing model based on the services the cloud services providers provide. This paper has benefitsfor giving the basic and over all knowledge and required information regarding cloud computing[9].

B.A Research paper on Smart Metering of Cloud Services [2]

In this paper they have presented a pricing model for cloud services, they have developed a model where the observed tariff is been varied based up on load prevailing oncloud infrastructure. In a particular time period and pricing they have obtained mapping between the load condition. Asper the consumer's discretion to continue using the service or to suspend usage a pricing for every time period is published. Making useof the (ARIMA) statistical model the load on the cloud infrastructure can be predicted using historical data They have proposed a well billing and pricing model for the cloud service providers service like amazon web services and rack space and price of the instances in cloud. This paper provides well documented algorithms for resource monitoring, price prediction, bill calculations. They have also listed the use of Hyper Sigar API framework for monitoring of resource utilization. Figures of variations of price with Infrastructure utilization and a graph for the prediction of the load. Gaps that can be identified in this paper is that the during the implementation for price prediction the use of auto ARIMA is not been implemented that would have given more reliable parameters for the ARIMA(p,d,q) and the authors have used only one statistical model for forecasing, comparison between different model would have been better and would also accuracy of different models would also be known..The advantage of reading this paper is that it gives a detail explanation of the time series model ARIMA for resource monitoring and price prediction.

Role of predictive modeling in cloud services pricing:A Survey[4]

This paper explains the pricing models of popular clouds like amazon, Microsoft,it also explains the analysis of a survey that the authors have done to prove why predictive modelling in cloud service pricing is important. The paper gives insight on different predictive techniques which include linear regression, logistic regression, binary classifier etc. The survey also describes about what can be the factors affecting cloud pricing. Gaps identified here are that less in detail explanation has been given in the section of the factors that affected in cloud computing. This paper can act as a hypothesis for those who might intend to work on predictive/ forecasting modelling.

Allocation of Resource in Cloud Computing [3]

In this paper the study is regarding the allocation of cloud-based services and its resources, in this research the researchers include what are the important strategies involved in the research allocation for mechanism for obtaining the guaranteed Vm resource allocation to the cloud users which should provide minimal resources struggle and avoiding over, under provisioning. The study also includes resource allocation policies which are followed by the cloud service provider company's which includes as follows: 1) Service Level Agreement, 2) Hardware Resources Requirement, 3) Policies, 4) Vm's. Service Level Agreement is basically the agreement done in between the end user and cloud service provide. Until a client becomes a big consumer of services of cloud the initiation of large utility ofproviders of cloud computing, most of SLA are standardized. The properties of resource allocation to assure SLAs has also been discussed which includes VM types, service initiation time, pricing of the VM's, data transfer time, data transfer speed. This research also proposes a architecture for the energy-aware resource allocation, the architecture includes Energy Monitor, VM managers, Accounting/Billing. This architecture gives overall details about the End-User interface, Cloud interface and Data centre functions.

PROPOSED ARHITECTURE

The Proposed Architecture scope given in the Fig-2 is divided into 5 interrelated phases given below:

Provisioning of Workload

The required cloud resources (Compute, Storage) will be allocated on a compute engine. A specific storage workload called metadata test (MDTEST) will be simulated using tools like file input-output (FIO) on a VM instance where values will be assigned to the command's parameters such as numjobs , time duration , size of the file in mb .

Metering the resources

The stated workload will be run with different variations in a snap of 1 to 2 weeks. The daily storage as a resource utilization and price of storage usage will be recorded in a time-seriessheet having months on the x-axis and storage consumed , price of storage on

the y-axis. After the simulation recording is done an .csv file which includes month column and price column willbecreated which will be used for heuristic/prediction model.

Curation of price and storage as a resource usage data

Normalize the price and storage as a resource usage data into common denominator and assuming 1MB equal to 1GB and the cloud price in USD and gettingrecorded data ready toproceed heuristic/prediction phase.

Forecasting of future Bill

Study the existing literature and prior art to understand and list the potentials time series such as ARIMA algorithm and approaches available for prediction or forecasting using such time series model to forecast the cloud cost. After the forecasting model is trained and tested on a python IDE. The results can be visualized.

Insights via visualization

The output of the prediction model can be visualized in a single pane of glass using either Kibana or Grafana visualization tools. A web interface will be developed where the user can upload their dataset file , select the month for which they want to forecasted value. In the backend the users given dataset will be accepted and trained and will generate the forecasted price which will be displayed on the dashboard.

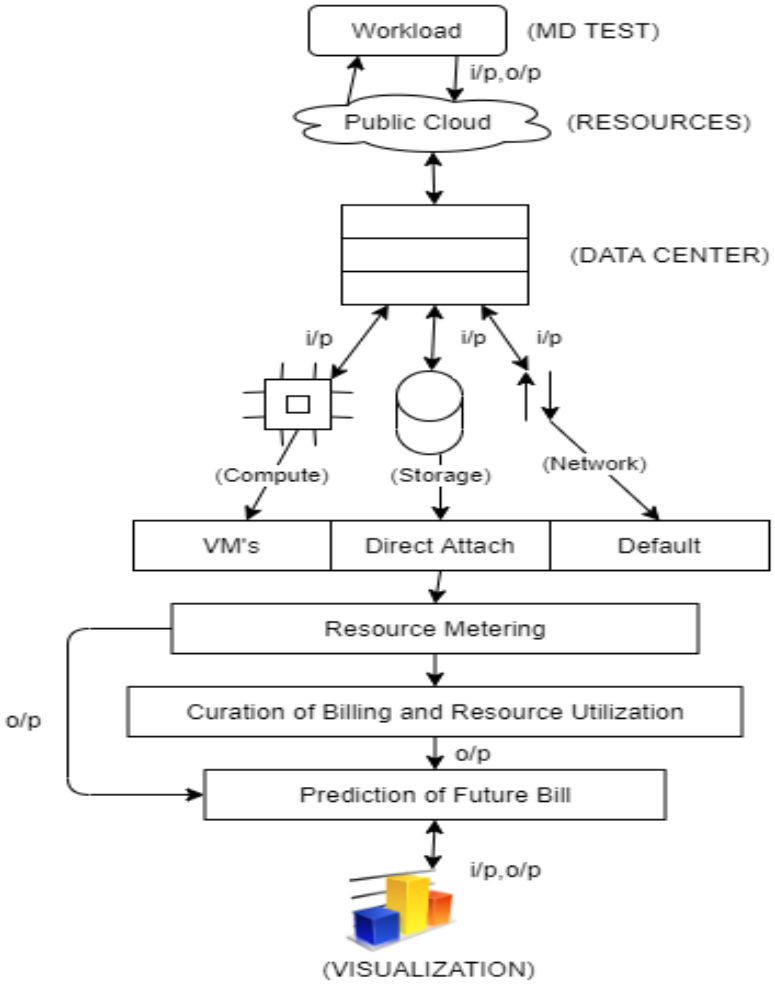

Fig-2 Cloud cost forecasting architecture

CONCLUTION

Cloud computing is amongst the most growing technology and is widely studied. It is almost used by all firms and individual users. This study of cloud cost forecasting using forecasting methods can benefit the firms to plan their budget and future resource consumption. After the implementation of the proposed architecture the study can be extended to apply to pricing prediction of other cloud-based services. It can be productizing as a microservice available on cloud for price and workload prediction. The enhancement can include comparative study with other time series prediction models like Dynamic Linear Models (DLMs) to model causal effects or Singular Spectrum Analysis

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