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Seasonal Trend Prediction an Approach with Genetic Algorithm

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Abstract

Scalability and elasticity are very important features in Cloud environment.Workload and demand prediction will help to properly utilise the resources in cloud environment. Analysis of workload can be done and future work load can be predicted for better resource allocation and efficacy of cloudplatform.

A suitable model for the prediction is being developed. Here Genetic Algorithm is chosen in combination with statistical model to do the workload prediction .It is expected to give better result by producing less error rate and more accuracy of prediction compared to the previous algorithms

Literature Review:

This section is aimed to conduct a review of the existing studies in this area and to identify problems with those approaches. Over the past few years a number of methods are been developed to predict cloud workload. In [2] They formed a prediction of the load to reduce the power cost. They compared the forecast performance of the ARIMA, seasonal integrated ARMA, and fractionally integrated ARMA with the singular spectrum analysis(SSA) method using resource trace collected from Wikimedia Grid. They showed that increasing the input size does not necessarily provide better forecasting results and the ARFIMA model suffers from a long computation time when the input size becomes larger. In [6] They suggested a prediction approach using a genetic algorithm to aggregate time seriesbased forecasting models. In it, workload prediction is done using the ARMA and ARIMA methods suggested by GA. They also applied the Holt-Winters approach to capture seasonality, but they do notprovide a cost model to be optimized. In [1] developed a tuned support vector machine- based approach that trains three support vector regression-based factors using the genetic and PSO algorithms. It uses a chaotic sequence to enhance forecast efficiency and prevented premature convergence by increasing the exploration and diversity in the search space. It also reduces the computational bur- den of generating random numbers in comparison to GA. In enhancement, kernel-based techniques are used to forecast memory and CPU loads. But, the TSVR takes a long time for tuning SVR parameters at the early stages of the algorithm

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Introduction

Cloud computing is an innovative technology that delivers various computing resources to its end users over a network as a-pay-for-use scheme. Unlike a traditional computing, it facilitates the automated scaling of resources according to needs in runtime as per the ser- vice level agreement (SLA) with the end-user. In this environment, workload[3] forecasting is a critical activity that needs to be carryout to achieve effective resource scaling[5].

To provide cloud services effectively for end-users conducting resource supervision in cloud data centers is of high importance[4]. and also can save energy thus by reducing CO_2 emission [8]

Fundamentally the methods to manage re- sources can be classified into two schemes as proactive and reactive. In the first scheme, feature workload is predicted in advance, using that an auto-scaling[7] mechanism scales up or down the resource accordingly. In the case of reactive, there are predefined threshold levels. Whenever the workload level crosses any of these predefined threshold values, the auto-scaling mechanism will react accordingly.

In comparison, the reactive scheme is easy to implement than the proactive. But when dealing with the sudden burst in workload, the reactive methods can lead to an SLA vi- olation since these methods always start only after the workload burst has occurred. proactive schemes can handle these sudden bursts very effectively due to their predictive auto- scaling nature. The prediction task in the above methodology is very significant since a faulty forecast can lead to several problems[3] mentioned below.

Under-provisioning : The running processes do not get sufficient resources to execute all their requests and may cause service level agreement variation.

Over-provisioning : Resources are allocated to the processes more than needed, which incurs wastage of resources.

Oscillation : A mixture of the above problems happen as a result of auto-scaling.

So to obtain the prediction accuracy, the forecasting algorithms need to find the usage patterns from the workload history and predict accordingly. Over the past few years, several studies are carried out in this area by using neural network, deep learning, statistical modelling. but only a few studies conducted with genetic algorithms (GA). This paper presents a GA based workload prediction algorithm that can achieve better accuracy

Data set used

To do the prediction we are using Rnd data set .The description of the data set is given below.

The dataset contains the performance metrics of **1,750 VMs** from a distributed datacenter from **Bitbrains**, which is a service provider that specializes in managed hosting and business computation for enterprises. Customers

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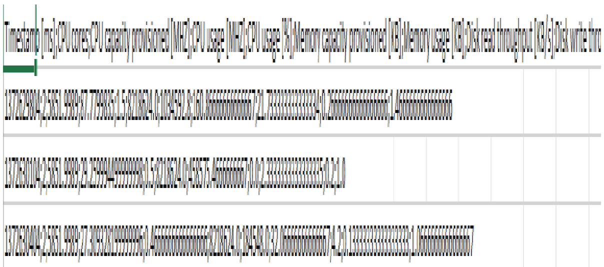
include many major banks (ING), credit card operators (ICS)etc.

In the Rnd directory, the files are organized into 3 sub-directories by the month that the metrics are recorded.
The format of each file is row-based, each row represent an observation of the performance metrics. Each column of a row is separate by ";\t" The format of each row is

1. Timestamp: number of milliseconds since 1970-01-01.
2. CPU cores: number of virtual CPU cores provisioned.
3. CPU capacity provisioned (CPU requested): the capacity of the CPUs in terms of MHZ, it equals to number of cores x speed per core.
4. CPU usage: in terms of MHZ.
5. CPU usage: in terms of percentage
6. Memory provisioned (memory requested): the capacity of the memory of the VM in terms of KB.
7. Memory usage: the memory that is actively used in terms of KB.
8. Disk read throughput: in terms of KB/s
9. Disk write throughput: in terms of KB/s
10. Network received throughput: in terms of KB/s
11. Network transmitted throughput: in terms of KB/s

<u>Format of the data set included</u>


Timestamp [ms];CPU cores;CPU capacity provisioned [MHZ];CPU usage [MHZ];CPU usage [%];Memory capacity provisioned [KB];Memory usage [KB];Disk read throughput [KB/s];Disk write thro

Working of the model

In our model we are going to predict the seasonal demand of our cpu and the parameters of the demand function is calculated using genetic algorithm,

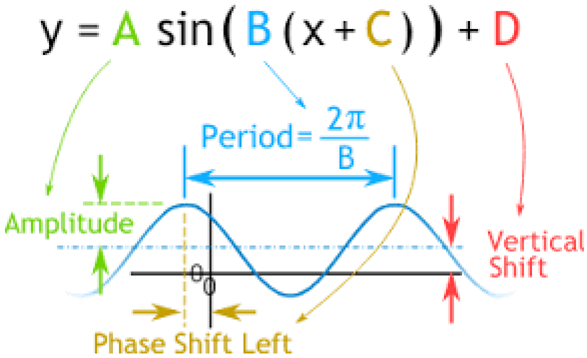
Genetic algorithm pseudocode

1.Calculate the initial population

2.Calculate the fitness of each chromosome
3.If the number of iterations equal to the max iterations defined
End
Else
Select chromosome for reproduction
Call crossover function
Call mutate function
Replace old population with new one
Return to step 2
End

<u>Demand Function</u>

The demand function is assumed to be the function of time.and it is periodical in nature for seasonal trend.So the periodical wave is sinusoidal in nature and we can represent it with the following formula



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CPU Demand(CD) function=A.sin(B.t+C) +D+Q.tU^{e}

Where D - Vertical offset
Q-Trend factor
A-Amplitude
B-Freequency
C-Horizontaloffset
CU-Cpu utilization
e-Elascity of cpu utilization

The above function has six parameters (A, B, C, D,Q, e) whose values are identified using real data. We use Genetic algorithm to identify these parameters

The above function has six parameters (A, B, C, D,Q, e) whose values are identified using real data. We use Genetic algorithm to identify these parameters

*Initial population consists of 500 individuals each with the chromosomes holding (A,B,C,D,Q,e) as gene which need to be identified using GA.We have used real value encoding and the values selected are random numbers from the dataset

Fitness Function

It is based on relative fitness that a given individual has a probability of entering into the next generation.

*.Fitness function is calculated with the following equation

F= $\sum R_t$ - (A.sin(B.t+C) +D+Q.t)tU^{e}

ie ($Demand_{actual}$-$Demand_{Pred}$)

Where R is the Real cpu utilization at pointtime t.
F the fitness value

*We have used tournament selection method which is simpler than roulette wheel selection

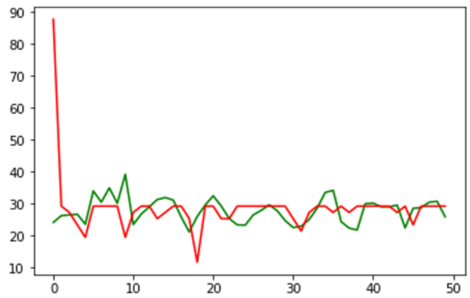
. mutation – invert one position in a chromosome,
- crossover - exchange of positions between two chromosomes.

Simulation

The Simulation has been carried out in python and the output for few data plotted below

Cpu Utilization-time Graph

Time



Cpu utilization

Actual data-Red
Predicted-Green
Graphical representation shows that the fitting of the model and its prediction is acceptable as there are less error between actual data and predicted data.

Conclusion:

The same work can be extended to bring out more variations on the Demand function and fitness function. Genetic algorithm is easier for getting the parameters of fitness function there by making the calculations much simpler. The same approach can be tested with cosine wave which works in similar manner.This experiment can be conducted with similar data set

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