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Workload Prediction in Cloud Environment during Seasonal Trend

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

I. LITERATURE REVIEW

I1] Holt- Winters exponential smoothing is extended with multi-seasonal cycles. Prediction accuracy is improved by employing Artificial Bee Colony algorithm to optimize its parameters.
In [2] time series prediction models using genetic algorithm is used to auto-scaling web applications hosted in the cloud infrastructure .It is a generic method to host Web application in the cloud It shows that the smaller the parameters: server processing rate and maximum response time.
In [3] Workload Prediction Using ARIMA Model and Its Impact on Cloud Applications' QoS was calculated. Showed that prediction of resources in advance improved QoS.
The author in[4] suggested that using genetic algorithms can be more effective in finding seasonal demand forecasting compared to winter model
In [5]improved fast computing prediction of requests for RAM and CPU resources for long sequence of data traces
Proposed models in [6] reduced the automatic scaling delay and also reduced mean absolute error
In[7]functional-an improvement for the FLNN is made by exploiting genetic algorithm (GA)that produced realistic scaling decisions closer to reality.
The paper [8] identifies the seasonality and trends as well as detect the changes (or spikes) in them and provide better prediction results
The paper [9]The integration of prediction strategies mentioned in this paper with auto-scaling process provides better performance and cost.
[10] proposed a type aware hybrid model that predicts workloads'.

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II. INTRODUCTION

Forecasting of the demand is one of the most important in decision making. Applying Artificial Intelligence techniques should improve correctness of demand forecasting. Identifying seasonal demand is one major task Here Identification of demand function's parameters is based on genetic algorithms (GA) approach.

Data set used

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

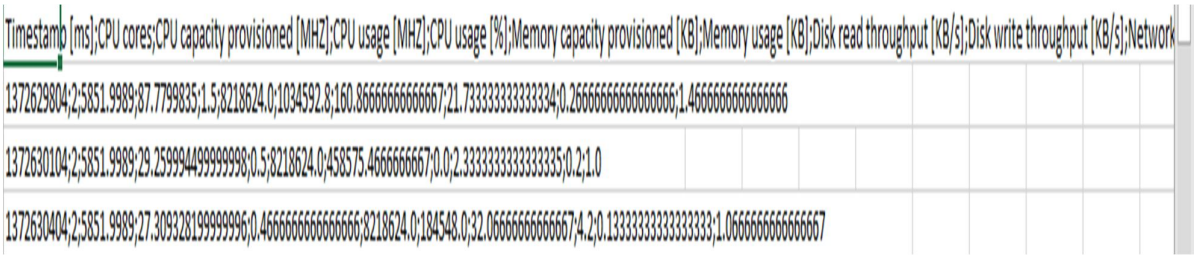
The dataset contains the performance metrics of **1,750 VMs** from a distributed datacenter from **Bitbrains**, which is a service provider that specializes in managed hosting and business computation for enterprises. Customers include many major banks (ING), credit card operators (ICS)etc.

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

Format of the data set included



Working of the model

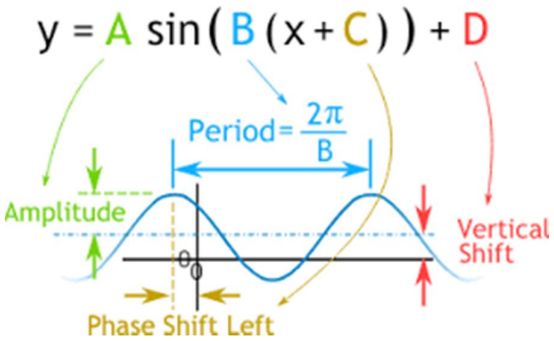
In our model we are going to predict the seasonal demand of our cpu and the parameters of the demand function is calculated using genetic algorithm,

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

Demand Function

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

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

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

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*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

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

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

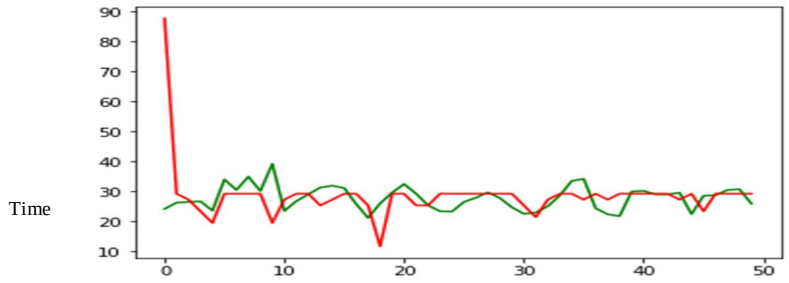
Where R is the Real cpu utilization at point time t.
F the fitness value

*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

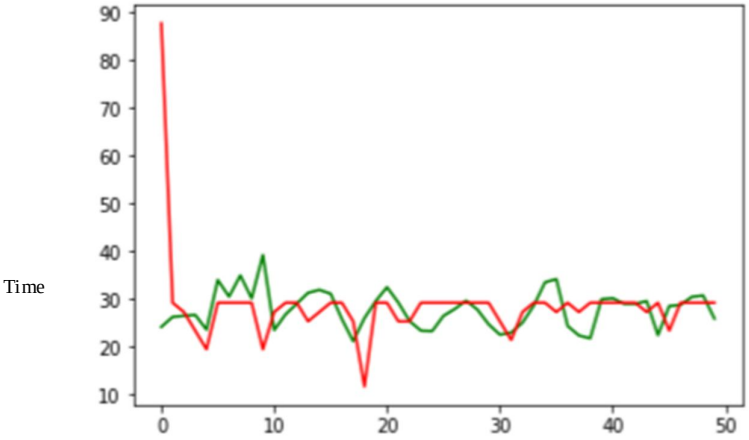


Cpu utilization

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.

Second variation of the work
The same approaches can be followed with a different method for fitness calculation.
Fitness is calculated using Mean Squared Error method = mean($(Demand_{real} - Demand_{pred})^2$

The plot for the same is shown below.



CPU Utilization

Here also we can see that the fitting of the model is good.
Third variation
Fitness is calculated using,
Root mean Squared Error= mean (sqrt ($(Demand_{real} - Demand_{Pred})^2$))

Time Literature Review
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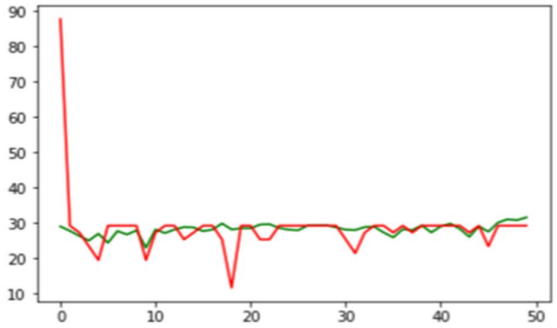

Cpu Utilization

III. 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.

References

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