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A Review on Ready Queue Processing Time Estimation Problem and Methodologies used in Multiprocessor Environment

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Abstract— CPU scheduling is a technique by which the processes in the system are able to be allocated the processor and by execution they perform their intended task. In order to this various scheduling schemes are available with their own merits and demerits. Lottery scheduling is one of the best algorithms to schedule the processes for the processor so that all processes get executed with the ease of convenience with better efficiency. Lottery scheduling solves many problems of previous scheduling schemes, starvation is one of them, flexible and fair share of resources to each and every process is possible with this scheme. This paper illustrates the various methods provided in the field of CPU scheduling and in the basic function of operating system that is process management to calculate the ready queue estimation time. Ready queue is responsible for holding the processes which needs to be allocated to the CPU for execution. It contains heterogeneous type of processes from the multiprocessor environment. The lottery scheduling scheme allows each process with its specific characteristics to share the resources and execute accordingly. Processes have the dynamic characteristics of creation, activation, waiting, execution, sharing, pre-emption, interruption and termination. The time spent by the processes in the ready queue waiting for CPU is a crucial time because it predicts the performance efficiency of the CPU. The problem of time estimation of ready queue processing is represented in this paper with various associated constraints to better evaluate the results. The working of lottery scheduling scheme and various algorithms which are derived from it are represented here. The summarized version of the existing work represented here to better understand the problem and predict the new possibilities in this area.

Keywords— scheduling algorithms, multiprocessor, process management, ready queue, estimation, operating system.

I. INTRODUCTION

An Interface which makes the hardware usability compatible to the user is known as operating system. The main purpose of operating system is to provide the services in efficient way and maintain the convenience to the user. Various operating systems available in literature are Linux, UNIX, Macintosh, Microsoft Windows Server 2003, Microsoft Windows Server 2008, Novell NetWare, BSD, Android and many more. The CPU is known as best if remain busy all the times, without being idle. Its efficiency depends on its throughput, which must be higher. Process management is one important functions of operating system in which the process concept, operation on processes, inter-process communication, process synchronization, deadlock, threads, communication in client/server systems and process scheduling can be learn. Various scheduling schemes are available in literature which decides efficiency of CPU that in what time it is able to process request of user.

In multi-processor environment scheduling is an important methodology to obtain the performance, efficiency and minimization of the delay of queue of processes. The task of scheduler is to optimize system performance according to some criterion of the system. Various policies and mechanisms are in built to govern the order for the completion of the work directed by the computer system [see Silberschatz and Galvin [10]]. The FIFO, Round Robin, LIFO and DRRA, Priority Scheduling, Multilevel queue scheduling, fair queue scheduling are some popular and well known CPU scheduling schemes available in the literature of operating system.

Rest of the paper is organized as follows, Section I contains the introduction of operating system, process management and ready queue and the associated scheduling algorithms. Section II contains the problem definition part which clearly mention about the work to be done. Section III contains the review of literature from various sources. Section IV contains the architecture and methodologies adapted. Section V concludes research work with future directions.

II. PROBLEM DEFINITION

A. In case when a system shut-down suddenly, this may be threatened to the processes. The estimation of ready queue processing time for all the processes will be difficult in this case. The estimation of all the processes processing time is a must requirement in distributed manner where some processes are running on other machines so that the process can be finished and system properly shut down in secure and systematic way.

B. Heterogeneity is another issue in ready queue processing time estimation. Size measure, type variant and requirement indifferences are some heterogeneous properties by which it's problematic to communicate and estimate the total processing time in ready Queue.

C. If random breakdown occurs, the running process requires estimating remaining process time estimation in ready Queue, for this reason a back-up manager is a must requirement to estimate how many jobs are remain un-allotted CPU and their time estimation in ready Queue.

D. A common belief that more related input information can predict the better results. In case of large number of ready Queue processes, the CPU utilization time can be predicted with some auxiliary information which may reduce the length of computed time interval.

III. REVIEW OF LITERATURE

Waldspurger and Weihl [1] presented lottery scheduling which is based on randomization and it is a novel resource allocation mechanism which provides efficient responsive control over relative execution rates of computations. One of its principle include modular resource management in which concurrent modules insulate the resource allocation policies from one another. For a flexible name, share, and protect resource rights a currency abstraction is introduced. I/O bandwidth, memory, and access to locks are some diverse resources generalized by Lottery scheduling.

Scheduling algorithms are a wide area of research in order to estimate the efficiency of processor. Shukla, Jain and Choudhary [2] presented a very effective and efficient algorithm known as systematic lottery scheduling scheme. This scheduling scheme based on principle of random process selection for the processor to work on. The objective is estimation of total processing time of the processes waiting in ready queue to be allocated to the CPU. In order to estimate the processing time some mathematical findings has been obtained by numerical analysis.

Shukla, Jain and Choudhary [3] contributed a probability based sampling model known as Group Lottery Scheduling (GLS). This model is able to estimate the total ready queue processing time in multiprocessing environment. Type-I and Type-II are the two types of allocation used in this scheme. In the multiprocessor environment the variations in both are compared and by using some numerical analysis the results are represented with efficiency.

Shukla, Jain and Choudhary [4] discussed about the lottery scheduling that how the ready queue processing time can be predicted in multiprocessor environment. The sampling method under k processor environment (k>1) is used to predict the processing time of jobs resided in ready queue. The sample data set is obtained by a random selection of processes by k-processors through without replacement method. This required collection of sample data is useful to predict the possible estimated time in ready queue. Also by using some theorems the desired result is obtained in terms of confidence intervals.

Shukla and Jain proposed analysis of ready queue processing time under PPS-LS and SRS-LS scheme [5] in the environment of multiprocessing where they demonstrate that when processes enters into the ready queue their size is in some bytes and by this information the estimation can be performed. With the help of some simulation of mean, variance and confidence interval it is shown that PPS-LS is efficient over SRS-LS

Shukla and Jain [6] have given a technique of E-F-T which is known as efficient factor type estimation in multiprocessor environment. In order to estimate the total processing time the two new proposed methods are compared. Performance compared in terms of mean squared error. The theoretical findings are obtained by the calculation of confidence intervals. Random sampling is performed in lottery scheduling for the optimization of bias and m.s.e of proposed estimators in large scale approximation.

Shukla and Jain [7] discussed the concept of auxiliary variables in multiprocessor environment where the ready queue mean time is estimated by using the Lottery Scheduling algorithm. The auxiliary data source is considered for the strengthening of the proposed methodology. Process size, process priority and process expected time are the three additional data sources used in this work. In multiprocessor environment after failure the remaining time of jobs are estimated by using a sampling technique known as the ratio method. The estimation of better processing time is done by the comparative study of different auxiliary sources. The highly correlated auxiliary information is obtained as a result.

Jain and Shukla proposed Factor-Type (F-T) estimator [8] in multiprocessor environment to estimate ready queue processing time where in terms of total processing time two new estimators T_A and T_B are used and compared with earlier ratio estimator. In the set up of lottery scheduling under large sample approximation the bias and m.s.e of proposed estimators has been obtained. For the theoretical findings the confidence intervals are calculated by using numerical analysis.

Shukla, Jain and Verma [9] elaborated in multiprocessor environment, the estimation of ready queue processing time using transformed Factor-Type (T-F-T) estimator. The contribution tries to find out the solution of the problem of ready queue time estimation. When there is a sudden failure in system and many processes remains in the ready queue an immediate action has to be taken for time estimation and for the calculation that before system shut down how much time is required for the remaining jobs in the ready queue. Now if we restart the system it will be held in a secure and safe manner. For this prediction a sampling technique is used in lottery scheduling.

In sampling literature the factor-type-estimation method is a popular technique to estimate the required time in ready queue in condition if the highly correlated auxiliary sources of information are available. In case if the available auxiliary source of information is negatively correlated the estimation of remaining total processing time to process the ready queue is predicted by proposing two new methods. In lottery scheduling scheme by the set up of random sampling the bias and M.S.E have been obtained. The performances of both the methods are evaluated by using the mean squared error. In comparative manner of both the methods the confidence intervals are calculated to obtain the efficiency that which one is better.

IV. METHODOLOGICAL REVIEW

A. Lottery Scheduling Procedure:

Scheduling is job of selecting a waiting process from the ready queue and allocating CPU to it. The processes were quickly switched onto CPU with time sharing to maximize the CPU use. The process scheduler select among available processes for next execution on CPU. Process scheduling maintains scheduling queues of processes, like job Queue which is a set of all processes in the system. A Ready Queue is a set of all processes residing in main memory, ready and waiting to be executed. The Device Queue is a set of processes waiting for an I/O device. The Process migrates among various Queues. The resources like memory and I/O bandwidth are limited. These limited resources must be maintained and properly controlled for the applications which are important. The traditional Schedulers available are FCFS scheduling, Round Robin scheduling, SJF and SRTF scheduling, priority scheduling and multilevel Queue scheduling. Some problem are encountered with traditional scheduler such as they are very complex and difficult to control, priority scheduler are ad-hoc, they have relative control over long running computation, poor performance when jobs have some length.

To overcome these deficiencies a Lottery Scheduling is introduced by Waldspurger and William Weihl in 1994. It is randomized, non-deterministic and a probabilistic approach. It also provides the dynamic control over scheduling. It support modular resource management and can be used to manage many scarce resources in the system like I/O bandwidth, memory etc. The analogy of Lottery scheduling is that variable numbers of lottery tickets are given to each process. Lottery scheduling hold lotteries to decide which thread will get CPU.

CPU time for a process = number of tickets to each process.

The question arises here is that how many tickets are given to each process? The longest running process gets more tickets and the shortest running process get less tickets. It means that resource rights are represented by lottery tickets.

B. Modified Lottery Scheduling

Step1. A token of some specified range of processors, suppose there are k processors named as Q_1, Q_2, Q_3,.....Q_k is assigned to a process as it enters ready Queue.

Step2. As stated in Step1, Q_1, Q_2, Q_3,.....Q_k processor generates unique and uncommon random number in similar specified range

Step3. Scheduler used to match processors token numbers to that of each process so that processor assign to that particular similar token process in ready queue has been performed

Step4. Repeat step 1, step 2 and step 3 in order to select another process in random manner until ready queue is vacated.

C. Systematic Lottery Scheduling Scheme

In this scheme a random process is considered for processing and according to some CPU logic unit the subsequent processes will be followed in a particular session, which takes into account the remaining possible time of the processes in the ready queue before the system shutdown abnormally. By some practical usage of this scheme it's clear that the queue time estimation is sharper. The confidence interval obtained states that Systematic Lottery scheduling can estimate the time of ready queue processing in advance.

D. Group Lottery Scheduling (GLS) scheme

In random selection of processes the larger as well as smaller types of processes have the same probability to be selected and processed which is not of so much use as the processes consists of heterogeneous property so that GLS is proposed in which the grouping of processes is done on the basis of type or size or some other characteristics. In this scheme size measure is considered and r groups are generated. The allotted token number of a process is matched with the random number of processor of a particular group and selected for processing. The CPU provides the estimated ready queue time t_{ij} of processes (k_1, k_2, k_3 ...kr) form r^{th} group.

E. Prediction of processing time using Lottery scheduling

A Sampling technique known as k-processor is applied in lottery scheduling environment. Random selection of processes without replacement method is done which gives a sample data to predict the estimated processing time of ready queue when system fails abruptly. By using various theorems the prediction to construct confidence interval can be performed with proof.

F. Efficient Factor Type Estimator (E-F-T)

A ratio method of estimation from the sampling techniques is applied to predict the ready queue time estimation. In lottery scheduling environment for random sampling the bias and M.S.E methods of prediction are applied. The efficient-factor-type estimation technique states that more input information generates a strong output. On the basis of this concept the methodology has been evolved and the efficacy of confidence interval is obtained.

G. Ready Queue Mean Time Estimation using Auxiliary Variables

In Lottery scheduling environment the sampling is a best way of prediction to obtain the desired results. Process size, process priority and process expected time are the three data sources used as auxiliary information. These parameters will help to predict the ready queue time estimation accordingly by calculating the highest correlation of the sources.

For the estimation of ready queue processing time some estimators such as population mean, population ratio and ratio estimate of total population are used for prediction and result observation. On some random samples the variance and covariance between auxiliary sources are obtained for better prediction and with their help reduced length confidence interval is calculated. It can be concluded that the methodology provide efficient and effective results. When auxiliary variables correlated with time it generates lowest length with desirable confidence interval.

H. Factor-Type Estimator

In lottery scheduling environment the auxiliary information produces better results so that two estimators T_A and T_B are introduced and compared with the ratio estimator. The bias, M.S.E and confidence interval are calculated to obtain the efficiency of the proposed algorithm. Class of FT estimator is

$$T_d = \bar{y}\left[\frac{(A+C)\bar{X} + fB\bar{x}}{(A+fB)\bar{X} + C\bar{x}}\right]$$

BIAS and M.S.E of T_A and T_B are

$$B(T_d) = \frac{(C-fB)\bar{Y}}{(A+fB+C)}\left\{\frac{C}{A+fB+C}V_{02} - V_{11}\right\}$$

$$M(T_d) = E(T_d - \bar{Y})^2$$

$$= \bar{Y}^2\left[V_{20} + P^2V_{02} + 2PV_{11}\right]$$

And the conference interval is as follows

$$P[T_A \pm 1.96\sqrt{V(T_A)} \le \bar{Y} \le T_A \pm 1.96\sqrt{V(T_A)}] = 0.95$$

$$P[T_B \pm 1.96\sqrt{V(T_B)} \le \bar{Y} \le T_B \pm 1.96\sqrt{V(T_B)}] = 0.95$$

V. DISCUSSION AND CONCLUSION

In view of all above existing schemes it is predicted that systematic Lottery scheduling scheme is a systematic way of representation of the problem whose confidence interval lies within true values. Group lottery scheduling modularized the problem in efficient way and represents a better solution. System failure management and better prediction of time can be done for remaining processes. For the purpose of disaster management and for backup of the procedures PPS-LS and SRS-LS are compared with the size measure and one can compare over another. Two variations of estimator's i.e T_A and T_B are represented by calculating their M.S.E, it is preferred to adopt T_B for the better prediction of time processing of ready queue. For calculating the remaining processing time of ready queue auxiliary information plays an important role where the highest correlated variable in contrast to time produces lowest confidence interval. Factor type estimator in comparison to ratio estimator produces better results as it reduces length of confidence interval. Transformed factor type estimation provides two types of estimators comparable on basis of many parameters such estimators are very useful in case of negatively correlated variables.

The problem undertaken herewith is related to the estimation of ready queue processing time. There are some existing methods but each one has merit and demerit. It is difficult to find a uniformly better method. After computation of proposed topic it is expected to come up with new methods of estimations more efficient than earlier in view of multiprocessor environment.

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