Physica A 417 (2015) 41–45

Contents lists available at ScienceDirect

Physica A

journal homepage: www.elsevier.com/locate/physa

On the optimization of multitasking process with multiplayer[☆]

Bin Zhou[a,b,*], Zhe He[a], Nianxin Wang[b], Zhendong Xi[c], Yujian Li[c], Bing-Hong Wang[a,d,e,*]

[a] Department of Modern Physics and Nonlinear Science Center, University of Science and Technology of China, Hefei, 230026, China

[b] School of Economics and Management, Jiangsu University of Science and Technology, ZhenJiang, 212003, China

[c] Joint Laboratory of Ocean based Flight Vehicle Measurement and Control, China Satellite Maritime Tracking and Control Department, Jiangyin, 214431, China

[d] College of Physics and Electronic Information Engineering, Wenzhou University, Wenzhou 325035, China

[e] School of Science, Southwest University of Science and Technology, Mianyang, Sichuan, 621010, China

HIGHLIGHTS

- A model of multitasking process with multiplayer (MPM) is proposed.
- The random choice strategy is better than the shortest queue strategy.
- If an individual first processed the time-consuming task, he probably could spend less time in completing all the tasks.

ARTICLE INFO

Article history:
Received 10 April 2014
Received in revised form 2 September 2014
Available online 20 September 2014

Keywords:
optimization
Multitasking process with multiplayer
Random choice strategy

ABSTRACT

In society, many problems can be understood as multitasking process with multiplayer (MPM). Choosing different strategies or different orders in processing tasks, an individual will spend a different amount of time to complete all the tasks. Therefore, a good strategy or a good order can help an individual work more efficiently. In this paper, we propose a model to study the optimization problems of MPM. The average time spent for all the tasks by an individual is calculated in each strategy, and we find the random choice strategy can make an individual spend less time in completing all tasks. The correlation coefficient between the order of each task processed by an individual and the corresponding time spent for all the tasks by the individual is also calculated. Then the internal statistics law between the order and the corresponding time is found and explains why the random choice strategy is better. Finally, we research the change of the queue length in each task with the time. These results have certain significance on theory and practical application on MPM.

The research on the dynamics of human behavior has been getting increased attention in the field of complexity science. In the past decade, a lot of work has been done to give a deeper understanding of human behavior [1–11]. These works mainly focused on the temporal and spatial distribution characteristics of human activity patterns. Because of the complexity of human behavior, many underlying mechanisms have not been discovered yet. We should research human behavior with more other aspects to get broader and deeper cognizance. With the development of society, people always hope to get more

☆ Fully documented templates are available in the elsarticle package on http://www.ctan.org/tex-archive/macros/latex/contrib/elsarticle CTAN.

* Corresponding authors at: Department of Modern Physics and Nonlinear Science Center, University of Science and Technology of China, Hefei, 230026, China. Tel.: +86 15256050957.

E-mail addresses: binzhou@mail.ustc.edu.cn (B. Zhou), bhwang@ustc.edu.cn (B.-H. Wang).

http://dx.doi.org/10.1016/j.physa.2014.09.031
0378-4371/

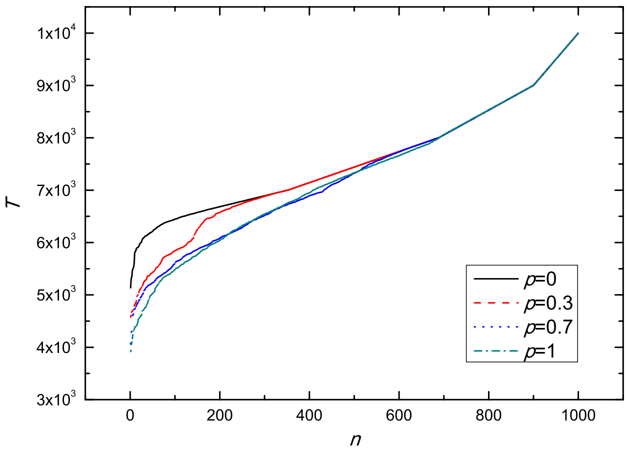

Fig. 1. The time T spent for all tasks by each individual. In order to facilitate the calculation and statistics, the parameters are assigned: $n = 1000$, $m = 100$, and $\tau_1 = 1$, $\tau_2 = 2$, $\tau_3 = 3, \ldots, \tau_{10} = 10$ unit times. n represents the number of each individual in the four sub-figures. The number n of each individual is from 1 to 1000, correspondingly, the time spent for all tasks by each individual is arranged from minimum to maximum. The black solid line, red dashed line, blue dotted line, dashed and dotted line represent the corresponding result in the case of $p = 0$, 0.3, 0.7, and 1, respectively. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

done in less time. Human-initiated systems always run in a complex way, so scientific management and time optimization are very important for human society. Multitasking process with multiplayer (MPM) is one of the complicated but common phenomena in daily life, such as physical check-up, for which each individual needs to complete all physical examination items of medical. There are some studies on a single-tasking process with multiplayer or multitasking process with a single-player [12–24]. But the study on MPM is, very few.

In this paper, we will present a model to study the optimization problems of MPM. Through simulation experiment and mathematical analysis, we research that which strategy is better and what is the intrinsic mechanism in the better strategy. These researches have certain significance on theory and practical application on MPM in reality. The outline of the paper is as follows. In Section 1, the MPM model will be presented. In Section 2, we show the simulation results of our model. In Section 3, we will summarize our works in this paper. The last part is our acknowledgments.

1. The model

Our model of MPM is stated as follows:

(i) there are n individuals and m tasks. All the tasks are numbered as $1, 2, 3, \ldots, m$. Correspondingly, the completion time of each task is $\tau_1, \tau_2, \tau_3, \ldots, \tau_m$ unit times. Each individual needs to complete all the m tasks. All individuals are independent of each other, and so are all the tasks;

(ii) in the beginning, all the individuals randomly choose one task. From the first time step, there are two alternative strategies for each individual to complete all the tasks. When an individual completed a task, the first strategy is that he will randomly choose a new one from the uncompleted tasks and the second strategy is that he will choose a new one with the shortest queue length among all the uncompleted tasks;

(iii) a fraction p of all the n individuals chooses the first strategy to process all tasks and the others choose the second strategy. In order to facilitate the simulation, we assume that 1 unit time is equal to 1 time step.

2. Simulation results and discussion

Fig. 1 shows the time spent for all tasks by an individual in the case of $p = 0$, 0.3, 0.7, and 1. The time is arranged from minimum to maximum. There is a minimum in each curve, and there are four minimums in the four curves. When $p = 0$, all the individuals choose the second strategy, and the minimum is the biggest in the four minimums. When $p = 1$, all the individuals choose the first strategy, and the minimum is the smallest in the four minimums. It is to say that the random choice strategy could make an individual spend less time in completing all the tasks than the shortest queue strategy. The maximum of each curve is equal to 10,000 time steps. The reason is that the most completion time of a single-tasking among 10 tasks is 10 unit times and there are 1000 individuals. Therefore, whichever strategy an individual chooses, the most time spent for all the tasks is $10 \times 1000 = 10{,}000$ time steps. What is more, the maximum is about twice as much as the minimum in each curve. No doubt, the gap between the maximum and minimum is quite obvious. If we can find the reason for the phenomenon, it must be of very important significance to optimize the running time of MPM in the model. In order to further understand the above findings, we need to do a more detailed study on the average time spent for all the tasks by an individual in each strategy.