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The Use Of Dynamic Programming On Allocation Of Added Health Services Servers

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ABSTRACT

Dynamic programming is an optimization procedure to create a sequence of interrelated decisions of a problem. The problem solved by breaking it into several sub-problems. Dynamic programming as an effective method in making a sequence of interrelated decisions. Therefore, it needs a recursive formula to obtain the optimal solution of a problem of decision making. There are two approaches in the dynamic programming namely backward dynamic approach (bottom-up approach) and forward dynamic approach (top-down approach). So that for each recursive dynamic approach has a different formula.

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INTRODUCTION

As a branch of mathematics, operation research is useful in everyday life. In general, the problems in operations research are solved simultaneously in one settlement. But often there are problems that can only be solved by breaking it into parts smaller and then merge back the sub-problems to obtain the desired solutions (Mulyono, S., 2004). The authors will apply dynamic programming on the allocation of health care server. If the demand for services exceeds the capacity of the service request, then will not get maximum service. Therefore, it needs optimal solution of a decision to get the optimum server capacity. The allocation of health care server will apply dynamic programming method to find optimal solutions in the allocation of health services server at The Cabangbungin Health Center as a case study.

Methodology:

(i) ***Dynamic Programming:***

Dynamic programming is a mathematical technique which often used to make a series of decisions that are related to systematic procedure to determine the combination of decisions that optimize the overall effectiveness of the decision (Buhisi, I.N. and A.S.S. Naser, 2009). Dynamic programming is an "approach" to problem solving and not a single algorithm which can be used to solve all kinds of problems. Thus, a separate algorithm is needed to solve any kind of problem.

The main theory is the principle of dynamic programming optimization. Optimization principle basically determines how a problem can be described correctly answered in each stage (instead of as a whole) through the use of recursive calculation (Hamdy, T., 2009). This optimization principle implies that when a decision is made multistage started at some stage, the optimal policy at later stages depends on the determination early stages regardless of how acquired a certain provision (Subagyo, P. *et al*., 1983)

(ii) Structure of Optimal Dynamic Programming:

The term is commonly used in dynamic programming, among others (Ilaboya I.R., *et al*., 2011):

1. Stage is part of the issue containing the decision variables.
2. Alternative, at each stage there is a decision variable and objective function that determines the value of each alternative.
3. State shows the link of one stage with the other stage, so that each stage can be optimized separately. The results of the optimization feasible for the entire problem.

In a decision problem to obtain the optimal solution using dynamic programming algorithm takes optimal dynamic programming structure, where in determining the optimal structure of the dynamic programming beforehand variables contained in the

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decision-making problem is formed into a linear programming model as follows (Sudradjat, 2010):

The objective function

Maximization

$$\sum_{i=1}^{n} P_i(x_i),$$

Constraints

$$\sum_{i=1}^{n} X_i = S$$

$$x_1, x_2, \ldots, x_n \geq 0 \qquad (1)$$

where:

Z = total services at all stages

x_i = quantity of servers allocated to the i-th stage

$P_i(x_i)$ = income (reward) of the i-th stage

n = number of stages

S = total server available for n stages

RESULTS AND DISCUSSION

(i) Recursive Formulation:

In determining recursive formula backward dynamic approach (bottom-up approach), the total available server S must be allocated in the order starting from the $n, n-1, n-2, \cdots, 1$ to achieve maximum results. When x_n number of servers allocated to stage n where $0 \leq x_n \leq S$, will obtained service $f_n(x_n)$ of these activities. Still possessed a number $(S - x_n)$ server available for stage $n+1$. The total health care of $n+1$ is shown by

$$f_{n+1}(S - x_n) = \sum_{i=1}^{n+1} p_i(x_i) - p_n(x_n),\ x_i \geq 0$$

(2)

Total health care of N stages, can be expressed as

$$f_n(S) = f_n(S, x_n) = p_n(x_n) + f_{n+1}(S - x_n)$$

(3)

Recursive formula for each state at each stage can be expressed as

$$f_n(S, x_n) = p_n(x_n) + max\ f_{n+1}(S - x_n)$$
$$= p_n(x_n) + f^*_{n+1}(S - x_n)$$

(4)

In this case to obtain the optimal solution to the allocation of server (the doctor) added is a health care problem in maximization. Recursive formula can be used both for the calculation of forward and backward in solving multistage problems.

(ii) Optimal Value with the Dynamic Programming:

In determining the value of an optimal, dynamic programs typically use one of two types of approaches (Wahid, F., 2004).

Suppose $x_1, x_2, \ldots, x_n$ declare variables decisions to be made each for phase 1, 2, … , n. then,

1. Forward dynamic program approach (Top-Down Approach)

Dynamic program moves from stage 1, go forward to stage 2, 3, and so on up to stage n. Sequence the decision variable is $x_1, x_2, \ldots, x_n$.

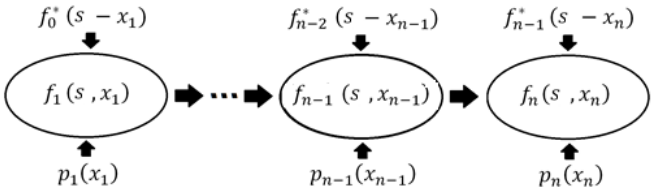

Fig. 1: Forward dynamic program approach

2. Backward dynamic program approach (Bottom-up Approach)

Dynamic program moves from stage n, continue back to stage $n-1, n-2$, and so on until the stage 1. Sequence the decision variable is $x_n, x_{n-1}, \ldots, x_1$.

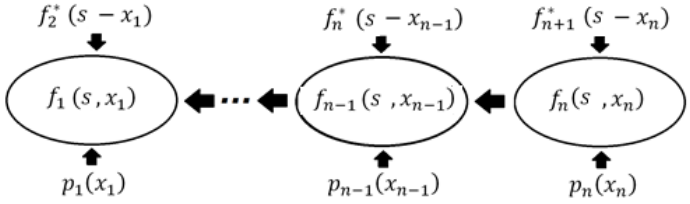

Fig. 2: Backward dynamic program approach

(iii) Case Study:

The data obtained from the results of research in The Cabangbungin Health Center during 10 month period from January 2013 to October 2013 is presented in Table 1.

Table 1: Data Visits Patient in The Cabangbungin Health Center

Month	The visits patient in The Cabangbungin Health Center 2013		
	Polyclinic (n)		
	1	**2**	**3**
January	3121	612	128
February	3165	679	132
March	3179	694	134
April	3187	925	137
May	3189	983	144
June	3212	1001	147
July	3217	1019	149
August	3258	1169	150
September	3325	1205	182
October	3350	1820	185

(iv) Dynamic Programming Optimal Structure of Health Services:

Suppose $p_1(x_1)$, $p_2(x_2)$, and $p_3(x_3)$ measure the effectiveness of allocating servers x to the clinic *i*, as given in Table 4.1 with the x_1, x_2, x_3 so (Sudradjat, 2010)

The objective function

Maximization

$$f_n(S) = \sum_{i=1}^{3} p_i(x_i),$$

Constraint

$$S = \sum_{i=1}^{3} x_i = 10$$

$$x_1, x_2, x_3 \geq 0$$

Solution

Obtained the optimal solution as follows: for $n = 3$ obtained $x_3^* = 1$. That is, allocated the added one server (doctor) for dental clinic, for $n = 2$ obtained $x_2^* = 8$. That is, allocated the added eight servers (doctor) for maternal and child clinic, and for $n = 1$ obtained $x_1^* = 1$. That is, allocated the added one server (doctor) for public clinic.

Summary:

The optimal solution to the allocation added server (doctor) health care for the polyclinic is (1, 8, 1) with the $f_1^*(10) = f_3^*(10) = 4418$, means added 1 server for general polyclinic, added 8 servers for maternal and child health clinic and added 1 server for the dental clinic. Three polyclinic resulted in an estimated total of 4418 patients received optimal medical each month. Optimal solution generated using backward dynamic approach (bottom-up approach) and forward dynamic approach (top-dowm approach) is equal to the public polyclinic, maternal and child health clinic and the dental clinic, the calculations can be performed using either of those two dynamic approach.

REFERENCES

Buhisi, I.N. and A.S.S. Naser, 2009. Dynamic Programming as a Tool of Decision Supporting. Gaza, Palestine: INSInet Publication Journal of Applied Sciences Research, 5(6): 671-676.

Hamdy, T., 2009. Operation Research An Introduction, 4th Edition, Macmillan, New York.

Ilaboya I.R., E. Atikpo, G. Ekoh, M. Ezugwu, O. Umukoro, 2011. Application Of Dynamic Programming To Solving Reservoir Operational Problems. Surabaya: Department of Environmental

Engineering Sepuluh Nopember Institute of Technology, 1(3): 251-262.

Mulyono, S., 2004. Operation Research. Lembaga Penerbit Fak. Ekoomi UI.

Nuraeni, Y., 2008. Pemakaian Program dinamik dalam pengelolaan & pengoperasian sumber daya air**.** Jurusan Teknik Informatika Universitas Paramadina: IST AKPRIND Yogyakarta.

Subagyo, P. *et al*., 1983. Dasar-dasar OR (Operational Research). Yogyakarta: BPFE Yogyakarta.

Sudradjat, 2010. DIKTAT: Pendahuluan Penelitian Operasional. Bandung: Jurusan Matematika Fakultas Matematik dan Ilmu Pengetahuan Alam Universitas Padjadjaran.

Wahid, F., 2004. Dasar-Dasar Algoritma dan Pemrograman. Yogyakarta: Andi offset.

Pusat Data dan Surveilans Epidemiologi, 2010. Profil Kesehatan Indonesia 2009. Jakarta: Kementerian Kesehatan Republik Indonesia.

Pusat Data dan Surveilans Epidemiologi, 2009. Profil Kesehatan Indonesia 2008. Jakarta: Kementerian Kesehatan Republik Indonesia.

Pusat Data dan Surveilans Epidemiologi, 2011. Profil Kesehatan Indonesia 2010. Jakarta: Kementerian Kesehatan Republik Indonesia.