Application of Web Based Book Calculation using Deterministic Dynamic Programming Algorithm

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Abstract. The library procurement materials is one of the technical services activities in a library as an effort to provide information needed by librarians. in doing the calculation of the procurement book (stock) of in library Universitas Malikussaleh still not automated and computerized and common error occurred on the the given amount of procurement the library because calculation was carried out using the tools count, with the application calculation book of stock it would make simply in calculation stock in library Universitas Malikussaleh. This application calculation stock of book is using deterministic dynamic programming algorithm for calculation process, deterministic dynamic programming itself is a method with gradually solutions and every stage will get an optimal solutions. By using this method it would know whether are the amount of stock of book has been Optimal. This Research conducted by the writer in unit. The library of Universitas Malikussaleh are taking total which start in 2012-2016 and the result by using dynamic programming deterministic algorithm is 270,779 as the optimal solutions in 2016.

1. Introduction
The rapid development of web applications since the advent of internet technology is very helpful in the ease and speed of delivery, delivery and acceptance of information\textsuperscript{[1]}–\textsuperscript{[3]}. Starting from companies, schools, colleges, and other institutions or organizations has been a lot of web applications in sales, promotions, learning activities and other activities where required delivery, dissemination and acceptance of information\textsuperscript{[4]}–\textsuperscript{[7]} so as to provide convenience for users (users) who need Web applications or can be called also with web-based software has grown rapidly both in terms of use, size, language used and the complexity\textsuperscript{[1]}, \textsuperscript{[8]}. Web apps were originally only static and navigated oriented websites, and more used as product brochures or online company profiles. At this time web
applications have a lot of dynamic, interactive and task oriented for use in information systems, telecommunications, commerce, banking and others.

In doing the calculation of the procurement (stock) of books in the Library of Malikussaleh university has been computerized but not yet systematized often occur inefficiency in procurement of library materials calculated considering the calculation is still using Microsoft Excel, and this is not comfortable for book calculation.

Looking at the problems that sometimes occur, a thought arises about how we can create something with internet-based technology to help solve the problem of stock book calculation, problem solving is done by deterministic dynamic programming approach[9].

2. Methodology
The optimization algorithm[10] can be defined as an algorithm or numerical method to find the value of x such that it yields f (x) of value as small as (or as large) as possible for a given function f, which may be accompanied by some limitation on x. here, x can be a scalar or vector of continuous or discrete values. The optimization algorithm is slightly different from the search algorithm or search algorithm[10]–[12]. In the search algorithm, there is a certain criterion which states whether an element xi, is a solution or not. In contrast, in the optimization algorithm there may be no such criteria but only objective functions that describe whether or not a given configuration is good[10]. Because the objective function can provide a more general definition of a problem, the optimization algorithm can be said to be a generalization of the search algorithm[9], [10], [12].

Based on the method of operation the optimization algorithm can be divided into two large classes, such as deterministic and probabilistic algorithms[10]; and in this study using deterministic algorithm. Dynamic Programming[13] is one of the algorithm design techniques developed to solve very complex problems by breaking the problem into many sub-problems[13]. Dynamic programming is one of the algorithms used to find the optimal value of a problem. In dynamic programming, the solution of a problem is divided into several steps until the solution of a problem can be viewed as a series of interrelated decisions[9], [13]. The use of deterministic dynamic programming in this study can be seen in Figure 1 below:

![Flowchart Deterministic Dynamic Programming](image)

**Figure 1.** Flowchart Deterministic Dynamic Programming
3. Result and Discussion

Dynamic programming algorithm is tasked to describe the steps of the number of book stock in a few years starting from 2012-2016 to determine the optimal data in the year for data processing engineer own research field study at the Library University Malikussaleh. In dynamic programming is divided into several stage then each stage will be compared with the decision value and maximization of data on the previous stage after it gets up to the nth stage then the step to determine the optimum is to combine some decision values (x) and maximize stock (fn) of each stock and then find the most optimum value in the decision (x), for example data used note table 1 below:

| Table 1. Book data each year |
|-----------------------------|
| **Year**       | **Total Stock** |
| 2012           | 60,985          |
| 2013           | 64,715          |
| 2014           | 66,039          |
| 2015           | 73,415          |
| 2016           | 87,824          |

The above data is the total of summed data from the General Collection and book data of the course of 2012-2016, with calculated formula as:

\[ f_n(S_n, X_n) = r_n(X_n); f_{n-1}(S_{n-1}) : n = 2, 3 \]

\[ X_n = 5 \text{(decision)} \]

\[ S_n = 5 \text{(Corresponding data)} \]

| Table 2. Initiation data |
|--------------------------|
| **F0** | 60,985 |
| **F1** | 64,715 |
| **F2** | 66,039 |
| **F3** | 73,415 |
| **F4** | 87,824 |

Therefore, the application of stock calculation of this book only calculate only do research on 5 years only then step from calculation of stock book in dynamic programming algorithm also as much as 5, for step 1 as in table 3 below:

| Table 3. First step |
|---------------------|
| **0** | **1** | **2** | **3** | **4** | **f_1** | **X_1** |
| 60,985 | 60,985 | 60,985 | 60,985 | 0 |
| 60,985 | 62,750 | 64,715 | 64,715 | 1 |
| 60,985 | 66,039 | 66,039 | 66,039 | 2 |
| 60,985 | 73,415 | 73,415 | 73,415 | 3 |
| 60,985 | 87,824 | 87,824 | 87,824 | 4 |

It is a series of early stages that will be a benchmark on the next data the formula \( f(s) = r(x) \)

\[ f(0) = (60,985) = 60,985 \]

\[ f(1) = (60,985) f_1(1) = (62,750) (1) \]

\[ f(2) = (60,985) f_2(1) = (66,039) (2) \]

\[ f(3) = (62,750) f_3(3) = (73,415) (3) \]

\[ f(4) = (66,039) (2) f_4(3) = (73,415) (3) \]

\[ f(5) = (66,039) (2) f_4(4) = (87,824) (4) \]
Phase 1 is equal to the original data that is \( f(s) = r(x) \) with the number of optimum stock obtained that is 87,824 at decision 4

**Table 4. Second step**

|   | 0   | 1   | 2   | 3   | 4   | \( f_2 \) | \( x_2 \) |
|---|-----|-----|-----|-----|-----|-------------|-----------|
| 0 | 121,970 | 121,970 | 0   |     |     |             |           |
| 1 | 123,735 | 123,735 | 123,700 | 0,1 |     |             |           |
| 2 | 127,024 | 125,500 | 127,024 | 127,024 | 0,2 |             |           |
| 3 | 134,400 | 128,789 | 128,789 | 134,400 | 0,3 |             |           |
| 4 | 148,809 | 136,165 | 132,078 | 134,400 | 148,809 | 148,809 | 0,4 |

Step 2 has a relationship with step 1 where each value will be added based on decision table after deducted in this first step. For more details can be seen in the formula below:

\[
\text{Formula } f_2(s) = r(x) + f_1(s-x_2)
\]

\[
f_2(0) = r(60,985)(x(0)) + f_1(60,985)(s-x_2)(0-0) = 121,970
\]

\[
f_2(1) = r(60,985)(x(0)) + f_1(62,750)(s-x_2)(1-0) = 123,735
\]

\[
f_1(1) = r(62,750)(1) + f_1(60,985)(s-x_2)(0-1) = 123,735
\]

\[
f_2(2) = r(60,985)(x(0)) + f_1(66,039)(s-x_2)(2-0) = 127,024
\]

\[
f_2(2) = r(62,750)(1) + f_1(62,750)(s-x_2)(2-1) = 125,500
\]

\[
f_2(2) = r(66,039)(x(2)) + f_1(60,985)(s-x_2)(2-2) = 127,024
\]

\[
f_2(3) = r(60,985)(x(0)) + f_1(87,824)(s-x_2)(3-0) = 148,809
\]

\[
f_2(3) = r(62,750)(1) + f_1(66,039)(s-x_2)(3-1) = 123,735
\]

\[
f_2(3) = r(66,039)(x(2)) + f_1(62,750)(s-x_2)(3-2) = 127,024
\]

\[
f_2(3) = r(87,824)(x(3)) + f_1(60,985)(s-x_2)(3-3) = 148,809
\]

\[
f_2(4) = r(60,985)(x(0)) + f_1(87,824)(s-x_2)(4-0) = 148,809
\]

\[
f_2(4) = r(62,750)(1) + f_1(73,415)(s-x_2)(4-1) = 136,165
\]

\[
f_2(4) = r(66,039)(x(2)) + f_1(66,039)(s-x_2)(4-2) = 132,078
\]

\[
f_2(4) = r(73,415)(x(3)) + f_1(62,750)(s-x_2)(4-3) = 136,165
\]

\[
f_2(4) = r(87,824)(x(4)) + f_1(60,985)(s-x_2)(4-4) = 148,809
\]

the next process is the third step, the value as follows:

**Table 5. Third step**

|   | 0   | 1   | 2   | 3   | 4   | \( f_3 \) | \( x_3 \) |
|---|-----|-----|-----|-----|-----|-------------|-----------|
| 0 | 182,955 | 182,955 | 0   |     |     |             |           |
| 1 | 184,720 | 184,720 | 184,720 | 0,1 |     |             |           |
| 2 | 188,009 | 186,485 | 188,009 | 188,009 | 0,2 |             |           |
| 3 | 195,385 | 189,774 | 189,774 | 195,385 | 195,385 | 0,3 |             |           |
| 4 | 209,794 | 197,150 | 193,063 | 197,150 | 209,794 | 209,794 | 0,4 |

Step 3 is the final step of the search for its values obtained initial data summed with the optimum value of the data in the previous step (step 2)

**Function** \( f_3(s) = r(x) + f_1(s-x_2) \)

\[
f_3(0)=r(60,985)(x(0)+f_1(121,970))(s-x_2)(0-0)= 182,955
\]

\[
f_3(1)=r(60,985)(x(0)+f_1(123,735,970))(S-X_2)(1-0)=184,720
\]

\[
f_3(1)=r(62,750)(1)+f_1(121,970)(S-X_2)(1-1)=184,720
\]

\[
f_3(2)=r(60,985)(x(0)+f_1(127,024))(s-x_2)(2-0)=188,009
\]

\[
f_3(2)=r(62,750)(1)+f_1(123,735)(s-x_2)(2-1)=186,485
\]
f3(2)=r(66,039)x(2)+f1(121,970)s-x2(2-2)=188,009
f3(3)=r(60,985)x(0)+f1(134,400)s-x2(3-0)=195,385
f3(3)=r(62,750)(1)+f1(127,024)s-x2(3-1)=189,774
f2(3)=r(66,039)x(2)+f1(123,735)s-x2(3-2)=189,774
f2(3)=r(73,415)x(3)+f1(121,970)s-x2(3-3)=195,385
f2(4)=r(60,985)x(0)+f1(182,955)s-x2(4-0)= 209,794
f2(4)=r(62,750)(1)+f1(184,720)s-x2(4-1)=197,150
f2(4)=r(66,039)x(2)+f1(188,009)s-x2(4-2)=193,063
f2(4)=r(73,415)x(3)+f1(182,955)s-x2(4-3)=197,150
f2(4)=r(87,824)x(4)+f1(182,955)s-x2(4-4)=209,794

Step 4 is the final step of the search for its values obtained initial data summed with the optimum value of the data in the previous step (step 3)

Function f3(s)=r(x)+f1*(s-x2)
f3(0)=r(60,985)x(0)+f1(182,955)s-x2(0-0)= 243,940
f3(1)=r(60,985)x(0)+f1(184,720)s-x2(1-0)=245,705
f3(1)=r(62,750)(1)+f1(182,955)s-x2(1-1)=245,705
f3(2)=r(60,985)x(0)+f1(188,009)s-x2(2-0)=248,994
f3(2)=r(62,750)(1)+f1(184,720)s-x2(2-1)=247,470
f3(2)=r(66,039)x(2)+f1(182,955)s-x2(2-2)=248,994
f3(3)=r(60,985)x(0)+f1(195,385)s-x2(3-0)=256,370
f3(3)=r(62,750)(1)+f1(188,009)s-x2(3-1)=250,759
f3(3)=r(66,039)x(2)+f1(184,720)s-x2(3-2)=250,759
f3(4)=r(60,985)x(0)+f1(182,955)s-x2(4-0)= 270,779
f3(4)=r(62,750)(1)+f1(195,385)s-x2(4-1)=258,135
f3(4)=r(66,039)x(2)+f1(188,009)s-x2(4-2)=254,048
f3(4)=r(73,415)x(3)+f1(182,955)s-x2(4-3)=258,135
f3(4)=r(87,824)x(4)+f1(182,955)s-x2(4-4)=270,779

the fifth step is the last dynamic programming process to determine the optimum value, note the following table 7:

|   | 0     | 1     | 2     | 3     | 4     | f5    | X5 |
|---|-------|-------|-------|-------|-------|-------|----|
| 0 | 304,925|       |       |       |       | 304,925| 0  |
| 1 | 306,690| 306,690|       |       |       | 306,690| 0,1|
| 2 | 309,979| 308,455| 309,979|       |       | 309,979| 0,2|
| 3 | 317,355| 311,744| 311,744| 317,355|       | 317,355| 0,3|
| 4 | 331,764| 319,120| 315,033| 319,120| 331,764| 331,764| 0,4|
After the search to stage 5, the last step is to compare each stage from step 1, step 2, step 3, and step 4 so that found the optimum value is \(= 331,764\) at the decision to 0 and 4.

4. Conclusion

The experiment process of calculating book stock, Dynamic programming algorithm deterministic is a method with the completion of a gradual process of data year 2012-2016, the data is described into smaller stages of the problem and dynamic programming to make the problem of the problem the process of the problem becomes more clear to be known, and also the use of dynamic programming algorithm on stock book calculation tends to be more flexible than other optimization techniques but it takes a long time to solve the problem because it describes the solution in several stages, from the results used using dynamic programming algorithm in the can that the optimum stock is 331,764 for 2016.

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