International Journal Of Health, Engineering And Technology (IJHET) E-ISSN 2829 - 8683
Volume 2, Number 3, September 2023, Page. 122 - 127
Email : editorijhess@gmail.com

Utilizing Dynamic Programming for Optional Shortest Route Determination

Winda Ade Fitriya B[1], Andre Anusta Barus [2]*
[1] Mathematics Study / Department of Mathematics, Faculty of MIPA, Cenderawasih University, Indonesia
[2] Pharmacy Study / Department of Pharmacy, Faculty of Pharmacy, Cenderawasih University, Indonesia

Corresponding Author
Email : windaafb97@gmail.com

Abstract

Fuel prices have seen a significant increase. This encourages individuals to save costs on their fuel expenditure by finding the shortest route to their destination. The shorter the route, the less fuel will be released. This study answers the challenge of determining the shortest route between BTN Lembah Furia Sentani in Jayapura Regency to the Department of Mathematics of Cenderawasih University in Papua Province. Many roads can be passed from BTN Lembah Furia Sentani in Jayapura Regency, to the Department of Mathematics of Cenderawasih University in Papua Province. As is well known, that the streets in Jayapura City have many alternative roads with different characters. The existing road characteristics include density, physical condition of the road and the size of the road width. With the existing road character, it can be assumed that each road has an average travel length. This average value is used as the cost of the road. To solve this problem, a dynamic programming approach is used to identify optimal routes while minimizing costs. The dynamic program utilizes analyzed and calculated data to yield the best outcomes. The results indicate that the quickest path from BTN Lembah Furia Sentani to the Mathematics Department at Cenderawasih University is via Komba Netar Bridge, GKI Petrus Waena Church, covering a distance of 25.2 kilometers.

Keywords: Dynamic Programming; Optimal Route; Costs Minimization, Determination, Multistage Graph

INTRODUCTION

One of the essential commodities in people's daily existence is fuel, often known as BBM. It is well known that recent gasoline price increases have nearly doubled. As the result, residents try to locate the shortest route possible in order to arrive at their destination promptly and affordably. As the result, determining the best or shortest route becomes an increasingly critical issue. Determining the nearest path is obviously difficult if the route to the target has a number of different routes.

Dynamic programming is a problem-solving strategy that divides the solution into phases, with the solution regarded as a sequence of interconnected decisions. Dynamic programming is more adaptive than many mathematical models and methodologies used in operations research. Dynamic programming is a mathematical approach used to optimize decision-making processes at various stages. This strategy optimizes judgments about an issue over time rather than all at once. The best policy is therefore defined as the best path of action. It is well acknowledged that dynamic programming can be used to solve a wide range of problems, such as allocation, cargo (knapsack), capital budgeting, inventory control, and path-finding.

Finding the shortest path has become critical. In everyday life, vehicle drivers frequently use shortest path finding to locate the shortest path from one location to another. As a result, a technique that can solve the shortest path problem that motorists can travel in order to get to their destination fast is required. Finding the shortest path to the destination is necessary because it can save time and money. The parameters of the standard shortest path issue are distance, time, and others between distinct points.

Each path contains features that distinguish it from others, such as one-lane roads, roads that are being repaired, timing discrepancies during peak hours, and so on. As a result, a system is required to assist in determining the shortest path that may represent data. The data may be saved, analyzed, and displayed in a more simplified format, making determining the quickest path easier.

In this study, dynamic programming techniques are employed in this work to discover the shortest and most efficient routes, presenting us with an approach for reducing transit distances by categorizing potential routes.

RESEARCH METHODS

Dynamic Program

Richard Bellman, a Princeton University professor who also worked at the RAND Corporation, coined the term Dynamic Programming in 1950. The connection between programming and the dynamic program process is indirect, but as the title of a project later offered to the United States Air Force by the RAND organization. The Dynamic Program performs forward and backward recursive calculations. The forward recursive calculation of the Dynamic Program begins with the first iteration and continues until the Dynamic Program is completed.

A dynamic program divides the problem into stages, with just one decision made at each level. Each stage is made up of various states that are related with that stage. Each stage's findings are turned back into states for the next stage. The expense created at each level increases on a regular basis. There is a recursive relationship in this technique that identifies the best decision for each state and enforces the optimality principle.

Dynamic programs apply the optimality principle to find the solution, ensuring that the answer is also optimal. According to this principle, if the complete solution is optimal, the portion of the solution up to the kth stage is also ideal. This means that in order to acquire the optimal result from stage k to stage k + 1, there is no need to recalculate from the first session, but can instead continue from the optimal result computation until the kth stage. This principle ensures that the decision taken at one stage is the correct decision for succeeding stages."

This dynamic program's challenges have various aspects, including:

1. The problem can be divided into phases, with each stage containing only one decision.
2. Each stage is made up of numerous states, which are the stages' possible inputs.
3. The outcomes of the decisions made at each

The Simplex approach, unlike the linear program, cannot be employed here. The model's formulation is attempted expressly in response to the situation. There are two types of dynamic programs: deterministic and probabilistic. The basic goal of dynamic programming is to make it easier to solve optimization issues that may be divided into stages. This problem is analogous to the core principle of a dynamic program, which is to reduce a problem into smaller and smaller problems so that it can be solved more easily. Dynamic programs give a formal mechanism for determining the decision-making combination that maximizes overall efficacy. Unlike the linear program, there is no generic mathematical formula (formula) in the dynamic program; rather, this dynamic program is a type for solving a problem using a universal approach method. The area utilized as an object is the exact route from my house, BTN Lembah Furia Sentani, to the Department of Mathematics, Cenderawasih University.

Multistage graph

Dynamic Programming is based on a multistage graph in theory. Each node in the graph represents a state, while V1, V2,... indicate stages.

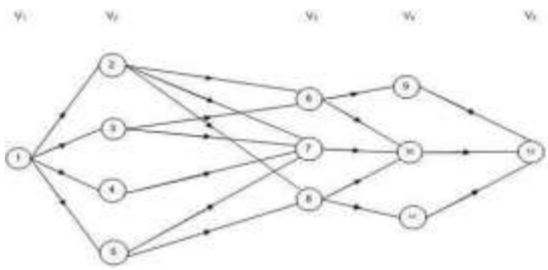

Figure 1. Graph Multitap (Munir, 2013)

It is known in the Multi-Stage Graph problem linked with Dynamic Programs:

1. Stage (k) is the process of determining the next destination node (e.g., Figure 2 has five stages).
2. Nodes in the graph represent the states (s) associated with each stage.

The shortest path from state s to x4 at step k is expressed by the recurrent relation:

$f_1(s) = c_{x_1 s}$ (base)

$f_k(s) = min\{c_{x_k s} + f_{k-1}(x_k)\}$ (recurrent)

$k = 2,3,4$

Description:

x_k : decision variable at stage k ($k = 2,3,4$).

$c_{x_k s}$: weight *(cost) of the* edge from $f_{k-1}(x_k)$: total weight of the path from s

$f_k(s)$: minimum value of fk (s,xk)

RESULTS AND DISCUSSION

The path from BTN Lembah Furia Sentani to the Department of Mathematics, Cenderawasih University Waena is known to take multiple detours. Figure 1 depicts other routes that can be taken. Using a Dynamic Program, calculate the alternate road with the shortest path.

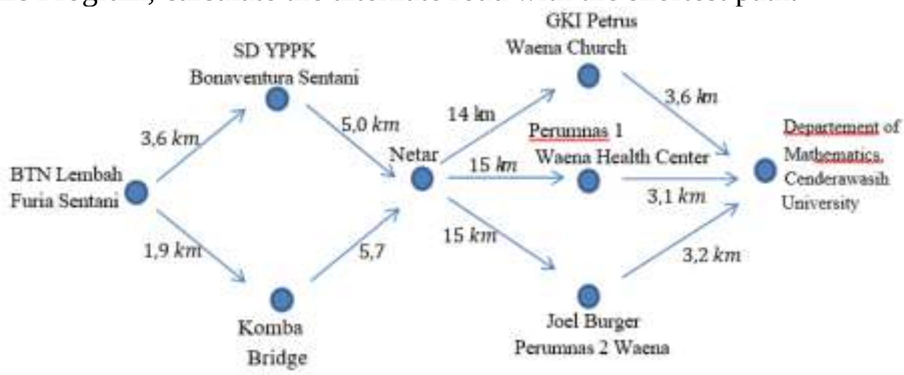

Figure 1 Map of BTN Furia Valley Sentani to the Department of Mathematics, Cenderawasih University Waena

To solve the problem of determining the shortest way or path, the current path map is separated into many pieces first. These components are phases that will be handled in order to obtain the best solution at each level. Figure 2 depicts a five-stage journey from BTN Lembah Furia Sentani to the Department of Mathematics, Cenderawasih University Waena.

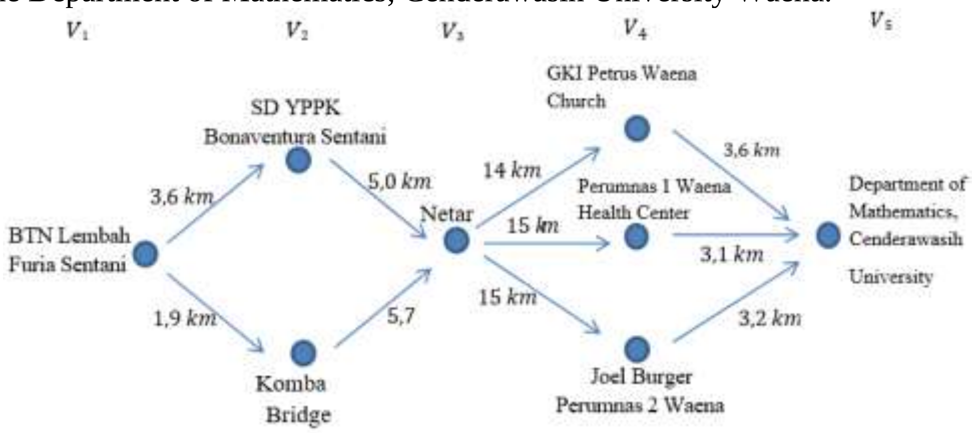

Figure 2 contains 4 stages on the travel map from BTN Lembah Furia Sentani to the Department of Mathematics, Cenderawasih University Waena.

Two things were done to establish the optimum approach to follow from BTN Lembah Furia Sentani to the Mathematics Department at Cenderawasih University Waena.

1) Select the decision variable V_n ($n = 1,2,3,4,5$) as the area to be travelled at stage n. so that the total route is V_1→BTN Lembah Furia Sentani and V_5 → Department of Mathematics, Cenderawasih University Waena.
2) Choose f_n (S, V_n) as the total cost for the overall policy of the next stage with the searcher

arriving at state S, ready to depart to stage n, by choosing Vn as the following destination.

In state S and stage n, using $V_n{}^*$ as an arbitrary minimum value of $f_n(S, V_n)$, use $f_n{}^*S$ as the minimum value of $f_n(S, V_n)$. So that $f_n{}^*S = min\ f_n(S, V_n) =, f_n(S, V_n)^*$, where $f_n(S, V_n)$ is the current cost at stage n, plus the cost of the next stage, i.e. stage $n + 1$ and so on, with the equation $f_n(S, V_n) = C_s(V_n) + f_{n+1}{}^*(V_n)$.

At the final stage $n = 5$, the journey is only fully determined by the currentstate of S, i.e. SD YPPK Bonaventura Sentani and the bridge. Komba's initial destination is the BTN Lembah Furia Sentani area. In order to $f_1{}^*$ (S, BTN Lembah Furia Sentani) = C_s (BTN Lembah Furia Sentani) At the initial stage $n = 1$ the results can be seen in Table 1.

Table 1 Stage 1

S	$f_1{}^*$	V_1
SD YPPK naventuraSentani	3,6	BTN LembahFuria Sentani
ombaBridge	1,9	BTN LembahFuria Sentani

Table 1 with the destination BTN Lembah Furia Sentani via YPPK Bonaventura Sentani Elementary School and Komba Bridge is known. Following that, stage 2 computations are performed:

Table 2 Stage 2

S	$f_3 = f_s + f_2{}^*$		$f_2{}^*$	V_2
	SD YPPK naventura Sentani	Komba Bridge		
Netar	8,6	7,6	7,6	Komba Bridge

Based on the preceding calculations, two paths are obtained:
Netar → SD YPPK Bonaventura Sentani = 3.6 + 5.0 = 8.6
Netar → Komba Bridge = 1.9 + 5.7 = 7.6

Table 3 Stage 3

S	$f_4 = f_s + f_3{}^*$	$f_3{}^*$	V_3
	Netar		
GKI Petrus Waena Church	21,6	21,6	Netar
Perumnas 1Waena Health Center	22,6	22,6	Netar
Joel BurgerPerumnas 2 Waena	22,6	22,6	Netar

Based on the calculations above, we have three options:
GKI PetrusWaena → Netar Church = 7.6 + 14 = 21.6
Puskesmas Perumnas 1 Waena → Netar = 7.6 + 15 = 22.6
Joel Burger Perumnas 2 Waena → Neutral = 7.6 + 15 = 22.6

Table 4 Stage 4

S	$f_5 = f_s + f_4^*$			f_4^*	V_4
	KI Petrus Waena Church	Perumnas 1 Waena Health Center	Joel Burger Perumnas 2 Waena		
Department of Mathematics, Cenderawasih University	25,2	25,7	25,8	25,2	KI Petrus Waena Church

Based on the calculations of the preceding stages, three pathways are obtained:

Department of Mathematics, Cenderawasih University → GKI Petrus Waena Church = 21,6 + 3,6 = 25,2

Department of Mathematics, Cenderawasih University → Puskesmas Perumnas 1 Waena = 22.6 + 3.1 = 25.7

Department of Mathematics, Cenderawasih University → Joel Burger Perumnas 2 Waena = 22.6 + 3.2 = 25.8

CONCLUSION

Based on the analysis of current data, the study identifies the shortest route with a distance of 25.2 kilometers from BTN Lembah Furia Sentani to the Mathematics Department at Cenderawasih University. The application of dynamic programming proved effective in optimizing travel routes and minimizing costs.

REFERENCES

Ambarsari, E.W., Marlina, D., dan Susanto, A. Analisa Efektifitas Jalur Terpendek Dengan Menggunakan Algoritma Semut Dan Pendekatan LeadTime: Studi Kasus Toko Gamis Murah Jakarta. Laporan Pertanggung Jawaban Penelitian Hibah Dipa LPPM Unindra.Jakarta : LPPM Unindra. 2014.

A. A. Putra, I. T. Bandung, and J. G. Bandung, "Dynamic Programming Paradigm in Determining Fuel Oil Distribution Routes Based on Population Needs in a Region," no. 13510010, 2013.

Fathoni, M. and Triprabowo, Pencarian Rute Terpendek dengan Menggunakan Dynamic Programming, Universitas Airlangga, Surabaya

H. Yunus and S. Martha, "Dynamic Program Method for Solving Traveling Salesman Problem," *Bul. Ilm. Mat. Stat. and Ter.*, vol. 04, no. 3,2015.

Jumadi, "Determining the Shortest Route to Campus Using Dynamic Programming Algorithm," *J. Istek*, vol. VII, no. 1, 2014.

Kumar, R. (2011). Research Methodology: A Step-by-Step Guide for Beginners 3rd Edition. London: SAGE Publications Ltd.

Luknanto, D., Program Dinamik Jurusan Teknik Sipil Fakultas Tekik, Universitas Gajah Mada, Yogyakarta. 2013.

Munir. R., "Deskripsi Sistem. Edisi ke-2". Bandung: Informatika. 2003.

M. N. Zein *et al.*, "Application of Dynamic Programming to Determine the Optimum Path for Aquarium Ceps Fry Delivery," *Bull. Appl. Ind. Eng. Theory*, vol. 3, no. 1, 2022.

Nurhidayati, F., U., Penggunaan Program Dinamik untuk Menentukan Total Biaya Minimum pada Perencanaan Produksi dan Pengendalian Persediaan, Skripsi, Jurusan Matematika, Fakultas

Sains dan Teknologim Universitas Islam Negeri Maula Malik Ibrahim, Malang. 2010.

Widyantoro, B., Arini, H. T. Sukmana, I. Muhamad Malik Matin, and D. Khairani, “The Effectiveness of forward-backward combination method in dynamic programming,” in 2021 Sixth International Conference on Informatics and Computing (ICIC), 2021, pp. 1–5, doi: 10.1109/ICIC54025.2021.9632910