,Application of Fuzzy Graph on Decision Making Agent

Fabian Zhafransyah and 13518022

Program Studi Teknik Informatika

Sekolah Teknik Elektro dan Informatika

Institut Teknologi Bandung, Jl. Ganesha 10 Bandung 40132, Indonesia

fabian_zhafransyah @students.itb.ac.id

Abstract—Every living being decide what to do everyday. We as a human being, the most complex living being in the face of earth, too, make decisions every day. As technology improves, our way of living gets even more complex. We have been working with a lot more people than we have always been. Now that we work in an industry, collaborating in a very large group of people, decision making gets really elaborate. A lot of factors goes in decision making and it seems impossible to make the right decision. Luckily, mathematics have our back, and we can make complex decision with agents through mathematics. We are able to discover the beauty of decision making through graphs.

Keywords— Decision making, graph theory, graph based application, fuzzy graph,

I. Introduction

Graph theory has been around for more than 2 centuries. It all started with a simple problem that was probably merely a quiz. It is said that the legendary Königsberg bridge problem is the puzzle that originates graph theory. Leonhard Euler is the man who famously solved the puzzle. The path that originates from the Königsberg bridge is now called the Euler path, which is a path of a graph without a repeating edge. The Königsberg bridge has no Euler path, hence no such path exists. Now, it has all sorts of applications in the real world. From scheduling meetings, city layouts, artificial intelligence, computer data, they all are partly an application of graph theory. It sure has grown a lot. Graph theory is the mathematics of relationships. We call the object to relate as a vertex, and the relationship between objects as an edge.

It seems pretty obvious that graphs might be able to be decision making agents. Software engineers have applied it as a common data structure, named decision tree. A decision tree has been around since the 20th century, for a matching population sample. However, to make a more elaborate decision that have criteria that relates to each other, we need more than just the common graph, because it would be impossible to solve a complex problem with just a monolithic system. Such problem is called Multi-Criteria Decision Making (MCDM) problem. How did such complex problems arise? The world's technology always improves everyday, and so does our dependence on the world's industry. People work with more people than ever, hence the management must be ever more complex. The goal is to have a model which can decide for us.

II. Preliminaries For Graph Theory

The basics of graph theory will be discussed here to make sure readers will be able to understand enough of the subject

1. Definitions

A graph is denoted by $G = (V, E)$, where V is a set of vertices and can be denoted by anything, and E is a set of edges that connect two of any vertices in V. Let e be an edge in E, and let e connect two vertices x and y in V, then the *endpoints* of e are x and y. Now e is denoted by

$$e = (x, y)$$

The two vertices that are connected by an edge are ***neighbors*** and they are ***adjacent***.

Simply put, a graph is anything that is an object, whose objects has relationships with other objects (possibly itself). The vertex and the edge of a graph may represent a lot of different things in regards to the context of how a graph is used.

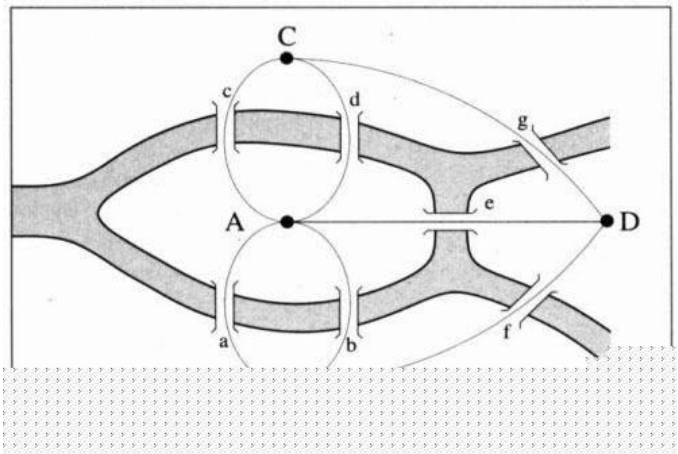

Fig 1. The Königsberg Problem represented by a graph

https://maffsisphun.files.wordpress.com/2018/02/konigsberg-bridge-problem-graph-and-image.jpg

Here is the Königsberg problem that Euler solved represented by a graph. It shows four distinguished lands named A, B, C, and D. They are connected by bridges, and the bridge can be represented using the edges a, b, c, d, e, f, and g. Notice that there are edges with the same pair of endpoints. In this case we do not want to focus on such graph. Graphs without any repeating edge, and no edge connects to the same vertex is called a ***simple graph***. A graph which aren't a simple graph are called a ***multi graph***.

A graph can also be distinguished by its edge direction. An edge may have a direction, which means you cannot traverse an edge in two ways. Such a graph is called a ***digraph*** or a ***directed graph***. In a directed graph, say there is an edge $e = (1, 2)$. Because it is a directed graph, e is not the same as $(2, 1)$.

III. Graph Based Multi-Agent Decision Making

Multi Agent System is an agent which consists of multiple intelligent agents that are affected with a variety of things which are usually called a criteria. A Multi agent system is capable to do complex problems that are impossible to do with an individual agent. The agent is confined into an environment that is targeted to fulfill our decision-making task. The decision factors of a MCDM problem consists of decision makers, alternatives and criteria, etc. To make decision that have multiple criteria that are connected to each other, we can show the relation between the multiple criteria using a graph. We call this kind of problems the graph-based multi-agents decision making (GMADM) problems. The GMADM problems occur broadly in almost all fields, such as politics, economy and military, and so on. For example, a situation of battlefield can be figured by a graph, where each combat unit is considered as a vertex, and there exits an edge between two agents if the corresponding combat units are hostile or coordinative. Any commander or command department wants to work out an operational plan so as to obtain as much benefit as possible. The GMADM model, developed in this paper, can help the commander or the command department to judge several operational plans and select the best one(s). The GMADM model can also be applied to assist a government in drawing up its policies or an enterprise in making its sales strategies. Therefore, how to solve these kinds of GMADM problems is meaningful.

Let us now set a basis for our talk on how a MCDM is built. Let X be a set of alternative decisions to be chosen, and C be a set of criteria to determine which decision is best. Let there be *m* decision alternatives. Let x_i be the *i*-th element of X, where $i = (1, 2, 3, \ldots, m)$. Let there be n criteria to choose x_i, and let c_i be the *i-th* element of C.

V. Conclusion

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

VI. Appendix

Appendixes, if needed, appear before the acknowledgment.

VII. Acknowledgment

The preferred spelling of the word "acknowledgment" in American English is without an "e" after the "g." Use the singular heading even if you have many acknowledgments. Avoid expressions such as "One of us (S.B.A.) would like to thank ... ." Instead, write "F. A. Author thanks ... ." Sponsor and financial support acknowledgments are placed in the unnumbered footnote on the first page.

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Fabian Zhafransyah dan 13518022