Graph Applications Using Graphviz in Drainage System: The Case in Madiun City, Indonesia

by Gregoria Ariyanti

Submission date: 28-May-2023 10:20PM (UTC+0700)
Submission ID: 2103708676
File name: 8-Graph_applications_using.pdf (677.75K)
Word count: 3136
Character count: 15898

Scitech
Research
Organisation

Journal of Progressive Research in Mathematics
E-ISSN: 2395-0218

Graph Applications Using Graphviz in Drainage System: The Case in Madiun City, Indonesia

Gregoria Ariyanti[1*], Ana Easti Rahayu Maya Sari[2]
[1]Department of Mathematics Education, Widya Mandala Surabaya Catholic University, Madiun City Campus , ariyantigregoria@gmail.com
[2]Department of Mathematics Education, Widya Mandala Surabaya Catholic University, Madiun City Campus , anaeasti42@gmail.com

Received: June 27, 2022; Accepted: July 27, 2022; Published: August 8, 2022

Cite this article: Ariyanti, G., & Sari, A. E. R. M. (2022). Graph Applications Using Graphviz in Drainage System: The Case in Madiun City, Indonesia. *Journal of Progressive Research in Mathematics*, *19*(2), 27-34. Retrieved from http://scitecresearch.com/journals/index.php/jprm/article/view/2157.

Abstract

There is a need for a drainage system in an area so that the potential for inundation or flooding during rainfall can be predicted to enable anticipatory steps to be taken. One way to present the drainage system is to use graphs. A graph is defined as a set of pairs (V, E), which in this case V is a finite non-empty set whose elements are called vertices and E is a set (possibly empty) of unsorted pairs connecting a pair of vertices called sides. In this study, a drainage system in Madiun City, Indonesia, will be presented in a graph using the Graphviz application. Graphviz is software that can be used to create a visualization of structured data such as network images.

Keywords: Graph; drainage; Graphviz.

1. Introduction

The existence of a sewer system in the neighborhood is needed so that the cleanliness and beauty of the environment are maintained. The sewer system in this case is the drainage system. By knowing the flow of water in a sewer or drainage, especially when it rains, the potential for inundation or flooding can be predicted so that it is possible to take anticipatory steps. To find out the water flow in the drainage system, a drawing or simulation will be designed that shows the distribution of water flow when it rains in the drainage channel in Madiun City. The method of presenting images or simulations used in this study uses a graph depicting the drainage system in Madiun City. Graph used to present the drainage system. The reason for using a graph is because on each side there is a current (flow) flowing between the 2 nodes that flank it [3]. Existing channels are deficient insufficiencies and need an angle and don't arrive at a reasonable outfall [8]. Seepage is gotten from the word 'to deplete' which is a term used to communicate frameworks identified with taking care of the issue of abundance water, both above and beneath the land settlement. The meaning of waste isn't restricted to the procedure of over-the-top water removal yet is all the more comprehensively identified with its connection to parts of life that are inside the metropolitan region [4]. Therefore, the water flow in the drainage system in the Madiun City area can be described as a graph originating from a higher area to a lower area. And if an area is in the form of a basin, then the water will only rotate in the area. To determine the distribution of water flow in the drainage channel, a simulation was built that shows the distribution of water flow in the Madiun City drainage channel.

A graph is defined as a set of pairs (V, E), which in this case V is a finite non-empty set whose elements are called vertices and E is a set (possibly empty) of unsorted pairs connecting a pair of vertices called sides ([6]; [2]). In order for the graph obtained to represent the drainage system information in the Madiun city area closer to the actual information, the graph presentation is carried out using a computer application, namely Graphviz. The Graphviz application is software that can be used to create structured data visualizations such as network images. In addition, Graphviz can be used to produce output images in formats such as GIF, PNG, and SVG.

The purpose of this research is to obtain information on the types of graphs found in the drainage system in Madiun City and knowing the graph presentation results in the drainage system in Madiun City using Graphviz.

2. Materials and Methods

2.1 The drainage system

The term drainage comes from English, namely drainage, which means to flow, drain, remove, or drain water. In addition, drainage is also defined as curves or drains on the surface or underground, either naturally occurring or man-made. Many also interpret drainage as ditches on the ground or underground culverts. Rainwater that falls in an area needs to be drained or disposed of, namely by making drainage channels that can accommodate rainwater that flows on the surface of the land. Drainage plays an important role in regulating water supply for flood prevention and is related to sanitation [1].

The urban drainage system is generally divided into 2 parts [7], that are major drainage systems and micro drainage systems. The major drainage system is a channel system that accommodates and flows water from a rainwater catchment area. In general, this major drainage system is also known as a major drainage system or primary drainage. This network system accommodates large-scale and wide-scale flows such as primary drainage channels, canals, or rivers. The micro drainage system is a channel system and drainage complementary structures that accommodate and drain water from the rain catchment area. Overall, included in the micro drainage system are channels along the side of the road, rainwater drains around buildings, culverts, city drainage channels, and so on where the water discharge it can accommodate is not too large. The drainage system for residential environments is more likely to be a micro drainage system.

2.2 Graphviz as software creates network visualization

Graph visualization is a way of representing structural information as an abstract graph and network diagram. One of the applications for creating graphic visualizations is Graphviz. This application can output images in various formats such as GIF, PNG, and SVG. Some of the commands in Graphviz are given in Table 1.

Table 1. Some of the commands contained in Graphviz

Commands	Function
dot	used for drawing directed graph
neato	drawing a standard graph, used if you want to draw an undirected graph. Suitable for graphs that are not too large (around 100 nodes)
fdp	draw a graph layout like neato
sfdp	draws a very large graph layout
twopi	drawing a radial layout
circo	draw a circular layout

Before creating a visualization of the graph to be presented in an image, the existing data is represented in a format that can be understood by the software, in this case, Graphviz [5]. The following is an example of how the graph output will look after the Graphviz program is run:

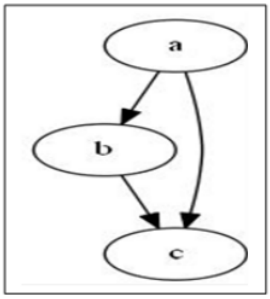

Figure 1: Simple Graph Output using Graphviz

Graph visualization can be displayed by first declaring the password or command in a format that can be understood by the graph application, in this case, Graphviz. The format used in Graphviz is the DOT format. Some DOT files that can be used in graph visualization are:

1. A DOT file that displays undirected graphs. An undirected graph is a graph whose sides have no directional orientation. Therefore, on an undirected graph, the order of the pair of vertices connected by the edges is not considered. So the sides connecting vertices 3 and vertices 9 which are presented as (3,9) = (9,3) are equal sides.

```
graph graphname {
rankdir=LR;
1 -- 2;
3 -- 2;
4 -- 1;
2 -- 5 -- 4;
}
```

Figure 2: Listing vizualitation with 5 vertex

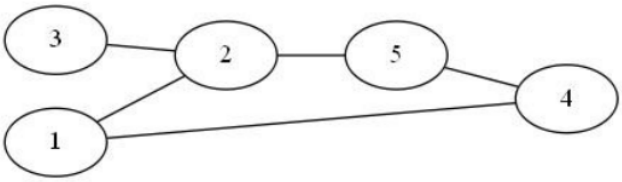

Figure 3: Graph vizualitation with 5 vertex

2. A DOT file that displays a directed graph. A directed graph is a graph where each side is given a directional orientation. In contrast to an undirected graph, in a directed graph, the order of the pair of vertices connected by edges is considered. So the side connecting vertex c and vertex e represented as (C, E) will be different from (E, C).

```
digraph graphname {
a->b;
a->c->d;
c->e;
}
```

Figure 4: Listing of directed graph

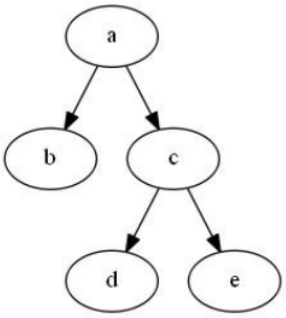

Figure 5: Directed Graph with 5 vertex

3. DOT file that displays attributes on the graph. Attributes are the names or identifiers of vertices on a graph.

```
graph graphname {
a [label="root";
shape=circle];
b[shape=box; color=red];
a -- b -- c [color=green];
b -- d [style=dotted];
a -- e -- f [color=blue];
f [label="leaf"];
}
```

Figure 6: Listing of graph attributes

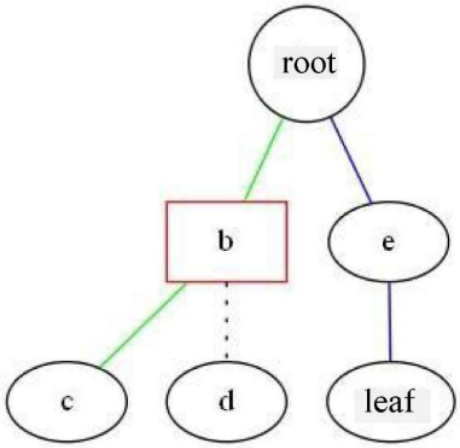

Figure 7: Listing of graph attributes

4. In addition, there is a listing for drawing a graph with a certain color and thickness on the sides or vertices.

```
graph {
rankdir=LR;
1 -- 2 [color=blue;
penwidth=4];
3 -- 2;
4 -- 1;
2 -- 5 -- 4 [color=red;
penwidth=3.5;
```

Figure 8 : DOT files with color variations on the sides or vertices

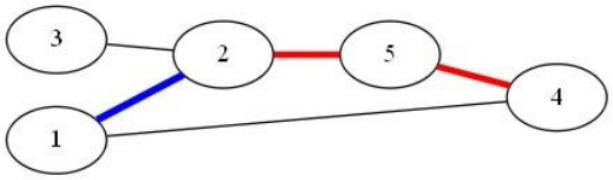

Figure 9: Listing of graph attributes from Figure 8

3. Results and discussion

Retrieval of drainage system data to related agencies. The data referred to is data on the drainage system in the Madiun City area. If the data is too large because it covers areas in Madiun City, with consideration of limited time and energy, then the data will be limited to certain areas in Madiun City.

This research is a type of field research [9]. Analysis and design of graph applications in the drainage system, in the form of making a drainage system model in the form of a graph using a computer application. At this stage the following things are done, there are : (1) model drainage systems and their intersections; (2) present the drainage system and its intersections in compatible graph form; (3) present a graph on the drainage system using the Graphviz computer application; and (4) analyze the types of graphs from the drainage system that has been presented using Graphviz. Presentation the drainage systems is use the following steps: make vertices, vertices represent roads or regions, determine the side to connect 2 vertices crossing or opposite each other with sides denote compatible object pairs, simplify compatible graphs, and converts a compatible graph to weighted directed multiple graphs.

This study is a graph presentation for the drainage system of Madiun City. Therefore, several restrictions were put in place, such as: graph system consists of vertices and edges. the nodes represent the channel ends and the channel branching, the sides represent each connected channel, the channels used are primary and secondary while tertiary channels are not taken into account, and water intensity and channel length were not taken into account in this study. For example, taken from a part of the drainage network map for Madiun City as in Figure 10 below.

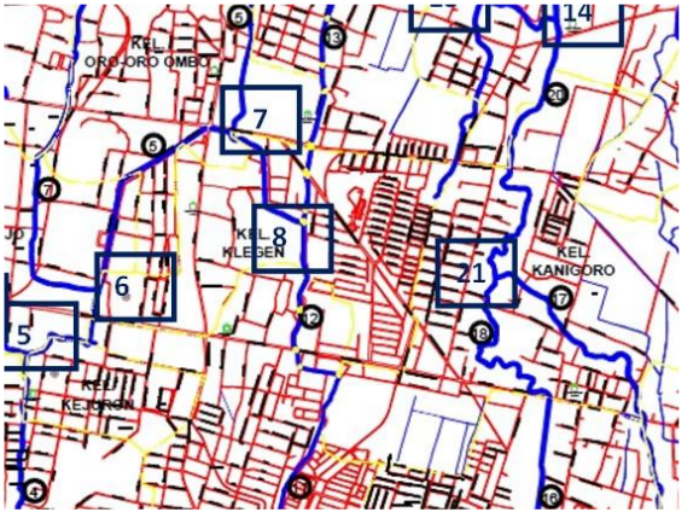

Figure 10: A part of Madiun City drainage system

Figure 10 shows the existing channels in some areas of the Oro-Oro Ombo Village, Klegen Village, Kanigoro Village, and Kejuron Village. As shown in the picture, the numbers are written in a small circle and a large square. The numbers written in small circles show the drainage channels in the area according to the documentation from the relevant department. The channels in question are given in Table 2 based on data obtained from the Madiun City PUTR Office [7].

Table 2. Drainage channels for Figure 10

Drainage Number	Drainage Name
4	Terate Channel
5	East Terate Channel
7	West Terate Channel
11	Mojorejo Channel
12	Klegen Channel
13	Pelitatama Channel
16	Manisrejo Channel
17	East Manisrejo Channel
18	Kanigoro Channel

The numbers written in large squares in Figure 10 indicate the node and drainage channels associated with that node. The related nodes and channels are given in Table 3 and Table 4.

Table 3. Node and drainage for Figure 10

Node Number	Relevant drainage number	Relevant drainage name
5	4, 5, and 27	Terate, East Terate, and Sumber Umis
6	4, 5, and 7	Terate, East Terate, and West Terate
7	5 and 12	East Terate and Klegen
8	5, 12, and 13	East Terate, Klegen, and Pelitatama
14	15, 20, and 21	Maling, Pilangbango, and Sono
21	17, 18, and 20	East Manisrejo, Kanigoro, and Pilangbango

Table 4. Graph of drainage channels for Figure 10

Starting node	Final node	Vertex	Related drainage
5	6	$\overline{5\ \ 6}$	Terate, East Terate, Sumber Umis, and West Terate
6	7	$\overline{6\ \ 7}$	Terate, East Terate, West Terate, and Klegen
7	8	$\overline{7\ \ 8}$	East Terate, Klegen, and Pelitatama
14	21	$\overline{14\ \ 21}$	Maling, Sono, East Manisrejo, Kanigoro, and Pilangbango

The formation of the sides in Table 4, is calculated based on the sequence number of the vertices and not based on the weight of the vertices. Thus, the formation of this graph does not use a weighted graph. The following figure is a listing in Graphviz obtained from Figure 10.

```
graph {
rankdir=LR;
5 -- 6 [color=blue; penwidth=4];
6 -- 7;
7 -- 8;
14 -- 21 [color=red; penwidth=3.5]
}
```

Figure 11: DOT Graph file for Table 4

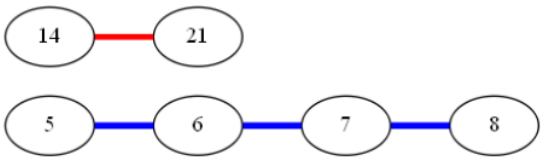

Figure 12: Graph visualization based on Figure 11

With the above method, a graph for the drainage channel of Madiun city can be presented with the following applications:

```
graph graph name {rankdir=LR;
1 -- 2;2 -- 3;2 -- 30;
3 -- 8;4 -- 5;5 -- 6;
5 -- 29;6 -- 7;7 -- 8;
9 -- 10;9 -- 25;9 -- 26;
10 -- 11;11 -- 12;11 -- 18;
12 -- 13;13 -- 14;14 -- 15;
14 -- 21;15 -- 16;16 -- 17;
16 -- 18;17 -- 18;17 -- 19;
19 -- 20;20 -- 27;22 -- 23;
22 -- 29;24 -- 25;24 -- 29;
26 -- 27;4 -- 30;4 -- 31;

29 -- 31;22 -- 31;1 -- 3;

23 -- 24}
```

Figure 13: DOT file of Madiun City drainage system

Based on Figure 13 which was worked on in the Graphiz application, the graph visualization is given in Figure 14.

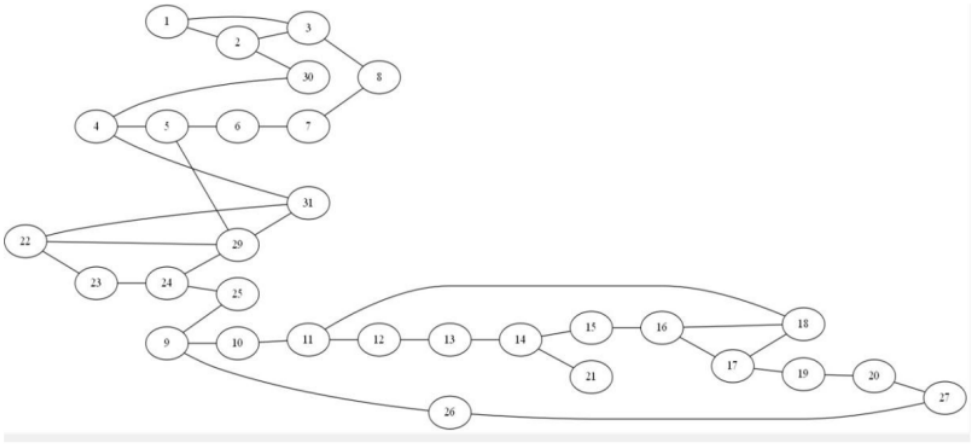

Figure 14: Graph visualization based on Figure 13

Furthermore, an analysis is carried out to answer the problem formulation related to graph visualization of the drainage system obtained by the Graphviz application. The following results are based on Figure 14 and Graph Theory :

1. Based on Figure 14, the drainage system graph for Madiun City obtained is a simple graph, not a multiple graph because no two sides are connecting the same two vertices and there are no rings or loops because they start and end at the vertices. the same one.
2. Based on the number of vertices on a graph, the drainage system graph for Madiun City is a finite graph, which is a graph with several vertices of 31.
3. Based on whether there is a directional orientation on the side, the resulting graph from the drainage system of Madiun City can be classified as an undirected graph.
4. A weighted graph is a graph where each side has a weight (value) [2]. Based on whether there is a weight or value on the side, the graph obtained from the drainage system of Madiun City is classified as a weightless graph because there is no weight on the side.
5. A graph that connects to all other points or each point is adjacent to all other points on the graph is called a Complete Graph [6]. Based on the graph generated from the drainage system of Madiun City, because all points are not adjacent to all other points on the graph, it is an incomplete graph.
6. Regular Graph, which is a graph that has the same degree or the same degree for each point. Because the resulting graph contains points that have different degrees, the graph of the drainage system in Madiun City is included in an irregular graph.
7. Bipartite Graph is a graph that has the property if the points can be separated into two independent subsets, then the end of each line lies on each set. The graph generated from the drainage system of Madiun City shows that it is not a bipartite graph.

Some things that have not been taken into consideration in the presentation of the graph of the Madiun City drainage system, that are: (1) data on the capacity of each channel, which includes the width, length, slope, height, and cross-sectional shape of the channel; (2) rainfall data in the drainage network area; (3) do not perform hydrological analysis of drainage channels, only perform network flow of drainage networks; and (4) does not differentiate between primary, secondary, or tertiary channels.

4. Conclusions

From the steps taken using the Graphviz application on the drainage system in Madiun City, a visualization of the drainage system graph is obtained which can be seen in Figure 14. The drainage system studied is limited to drainage data provided by the Public Works and Spatial Planning Office of Madiun in 2020. So this research is limited to not examining small drainage in the entire drainage in Madiun City.

References

[1] Alhaafizh, K. (2017). *Building a Drainage System by Implementing Graphs in Medan City*. Department of Informatics, ITB, Bandung.

[2] Baskoro, E. T. (2005). *Combinatoric*. Departement of Mathematics, ITB, Bandung.

[3] Cormen, H, Charles, L, Stein, C. (2001). *Introduction to Algorithms, Second Edition*. MIT Press and McGraw-Hill, New York.

[4] Dwiuntoroadi, S, & Lasminto, U. (2020). Numerical modelling of sub-surface drainage system in Citraland, West Surabaya. *IOP Conference Series : Materials Science and Engineering* (p.930(2020)012082). IOP Publishing.

[5] Khoury, M. (2013). *Let's Draw a Graph : An Introduction with Graphviz*.

[6] Munir, R. (2016). Discrete Mathematics. Bandung: Informatics Publisher.

[7] *Procedure for Preparation of the Urban Drainage System Master Plan*. (2012). Ministry of Public Works Directorate of Human Settlements, Indonesia.

[8] Rahman, A, Haque, M, Saha, R, Hossain, S. (2014). Storm Water Management for Urban Area of Bangladesh by Analytical & Modelling Approach : A Case Study of Chalna Municipality. *The 2nd International Conference on Civil Engineering for Sustainable Development*. Bangladesh.

[9] Sugiyono. (2014). *Quantitative, Qualitative, and R&D Research Methods.* Alfabeta Press, Bandung.

Graph Applications Using Graphviz in Drainage System: The Case in Madiun City, Indonesia

ORIGINALITY REPORT

6%	6%	2%	0%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	scitecresearch.com Internet Source	2%
2	repository.uki.ac.id Internet Source	1%
3	dokumen.pub Internet Source	1%
4	jecombi.seaninstitute.org Internet Source	1%
5	docshare.tips Internet Source	1%

Exclude quotes	On	Exclude matches	< 1%
Exclude bibliography	On		