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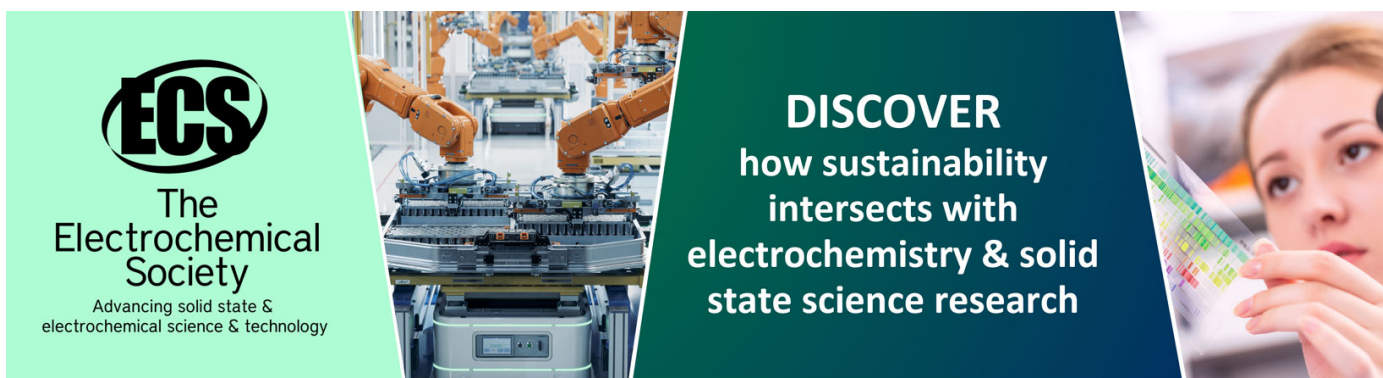
Comparative of prim's and boruvka's algorithm to solve minimum spanning tree problems

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Comparative of prim's and boruvka's algorithm to solve minimum spanning tree problems

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Abstract. Optimization is important in an algorithm. It can save the operational costs of an activity. In the Minimum Spanning Tree, the goal is to achieve how all vertices are connected with the smallest weights. Several algorithms can calculate the use of weights in this graph. The purpose of this study is to find out the Primary electricity distribution network graph model and correct algorithm to determine the minimum spanning tree. By comparing two algorithms, Prim's and Boruvka's algorithm, it will get an efficient algorithm to solve the minimum spanning tree problem. To get the output it takes several steps: Data collection: Designing Model: calculating the minimum spanning tree of Prim's algorithm, the Boruvka's algorithm: Comparing the efficiency of each algorithms. The analysis shows that the Prim's and Boruvka's algorithm have different steps even though the final result in the form of weights obtained in achieving the minimum spanning tree is the same. But in the case of electric network optimization, the Prim's algorithm is more efficient.

Keyword : *Minimum spanning tree*, Prim's Algorithm, Boruvka's Algorithm

1. Introduction

Algorithms development and various fields of mathematical studies have been carried out to in solving the problems of infrastructure development in an area such as the networks of electricity, telephone, clean water, transportation etc. This development certainly requires supporting factors, such as cost, time and energy. Actually this can be overcome by using tree modeling in graphs. Estimating electricity consumption is important for energy planning systems [1]. The speed and security system are important in sending digital information [2]. The Minimum spanning tree (MST) is a tree that connects among the vertices of the results to minimize the weight that is in the complete graph. Graph is a mathematical representation of facts related to distance [3]. Graphs can produce several ranges that have different weights [4]. The smallest weight is MST. In designing the primary electricity distribution network, it is necessary to consider the cost factor which is closely related to the length of the cable used. Calculating the minimum cable length required from a network and considering the cabling arrangement is very important in primary electricity distribution networks. To achieve optimum system performance conditions in the primary electricity distribution network can be achieved by determining MST [5]. There are several algorithms to solve the MST problem, including the Prim's and Solin's Algorithm. Prim's algorithm is suitable for trees with a large number of vertices and will always be able to find a minimum spanning tree but the resulting spanning tree is not always unique without having to sort first [6]. The



Boruvka's algorithm is a minimum spanning tree by examining each node and adding the side with the smallest weight to the spanning tree, without paying attention to the side that has been added, and continuing to merge the side until they form a spanning tree. In solving the MST problem now, researchers generally use The Prim's or the Kruskal's Algorithm while the Boruvka's Algorithm is very rarely discussed by researchers. Therefore, the writer is interested in discussing Boruvka's Algorithm and comparing it with Prim's Algorithm to see which algorithm is better in solving the minimum spanning tree problem in Grand Asia City Housing in Labuhan Ruku by PT.PLN Tanjung Tiram branch in Batubara Regency and making electrical cable network simulation by using a program. In this study a primary electricity distribution network model was designed using a directedless graph connected to $G = (V, E)$ where V is the set of electric poles in those housing, and E is a possible set of connections among the electrical poles such as the form of the length of the network cable. Furthermore, it is calculated and simulated by a computer program to get the MST primary electricity distribution network using Prim's and Boruvka's algorithm. Furthermore, by examining the performance of the Prim's algorithm, the Boruvka's algorithm takes the form of complexity time concerning to the efficiency of algorithm.

2. Methodology

The method used in this research is a quantitative analysis consisting of defining the problem, developing the model, obtaining input data, developing the solution using Prim's and Boruvka's algorithm, testing the solution, analyzing the results, applying the results

2.1. Prim's algorithm

This algorithm was discovered in 1930 by mathematician Vojtech Jarnik and then separately by computer scientist Robert C. Prim in 1957 and rediscovered by Dijkstra in 1959 [7]. Prim's algorithm is one algorithm that works greedy. Prim's algorithm forms step by step MST. At each step, the graph G side has a minimum weight and is connected to the minimum spanning tree that has been formed. Prim's algorithm is used to find the minimum crop of a connected graph by taking the edge that has the smallest weight of the graph, where the edge is adjacent to the measured tree that has been created and which has no cycle [8]

In [4] Prim's algorithm is given as follows.

Input: Undirected - weighted graph

Output: minimum spanning tree T

$T \leftarrow \emptyset$

Example r is any point in V

$U \leftarrow \{r\}$

While $|U| < n$ do

Determine $u \in U$ and $v \in V - U$

So that sides (u, v) is between U and $V - U$

$T \leftarrow T \cup \{(u, v)\}$

$U \leftarrow U \cup \{v\}$

In general, if G is a weighted connected graph, the steps to obtain MST using Prim's algorithm are as follows:

- T is still empty
- Choose a point randomly and select the related side with minimum weight and enter it in T
- Choose sides (u, v) with minimum weight and side by side at T , but (u, v) do not form a circuit at T . Add (u, v) to T .
- Repeat the above steps $n-2$ times.

The total number of steps in the Prim's algorithm is $n-1$, which is the number of sides in the spanning tree with n points.

Output : *minimum spanning tree* 



2.2 Boruvka's algorithm

The Boruvka's algorithm is the first algorithm to find the minimum spanning tree of a graph. Boruvka's algorithm was discovered by Otakar Boruvka in 1926. [9]

Boruvka's algorithm for finding the minimum spanning tree in graph :

- Copy the dot from graph G to the new blank graph L
- Whereas L is not connected (it means that forest has more than one tree)
 - For each tree on L , connect one point to another point on the other tree on L by adding the minimum weighted sides [10]

3. Results and discussion

Complexity comparison of the Prim's and the Boruvka's Algorithm in solving MST problems was built using the Python programming language and also designed visual from the results of MST problem solving by the Matlab program. In this research, The built algorithm will be compared and analyzed to see which algorithm is the most efficient based on the complexity of each algorithm. The data used was the data of grand asia city housing located on the sloping market road in Talawi sub-district, Luku Ruku coal district, which consists of 91 houses, they will be connected to the electricity network.

Table 1. Graph weight data with 91 vertices

No	Edge		Weight
	i	J	
1	1	2	6
2	1	89	14
3	1	90	10
4	2	3	6
5	3	4	6
6	4	5	10
7	4	9	14
8	4	89	10
9	5	6	6
10	5	9	10
11	6	7	6
12	7	8	6
13	8	9	14
14	9	10	7
15	10	11	7
16	11	12	7
17	12	13	7
18	13	14	7
19	14	15	7
20	15	16	7
21	16	17	7
22	17	18	7
23	18	19	7

24	19	20	7
25	20	21	7
26	21	22	7
27	22	23	7
28	23	24	7
29	24	25	7
30	25	26	7
31	26	27	7
32	27	28	7
33	28	29	7
34	29	30	10
35	29	70	10
36	30	31	7
37	30	70	14
38	31	32	7
39	32	33	7
40	33	34	7
41	34	35	7
42	35	36	7
43	36	37	7
44	37	38	7
45	38	39	7
46	39	40	7
47	40	41	7
48	41	42	7
49	42	43	7
50	43	44	7
51	44	45	7
52	45	46	7
53	46	47	7
54	47	48	7
55	48	49	7
56	49	50	10
57	50	51	7
58	51	52	7
59	52	53	7
60	53	54	7
61	54	55	7
62	55	56	7
63	56	57	7
64	57	58	7
65	58	59	7
66	59	60	7
67	60	61	7
68	61	62	7
69	62	63	7
70	63	64	7
71	64	65	7
72	65	66	7
73	66	67	7
74	67	68	7

75	68	69	7
76	69	70	10
77	70	71	7
78	71	72	7
79	72	73	7
80	73	74	7
81	74	75	7
82	75	76	7
83	76	77	7
84	77	78	7
85	78	79	7
86	79	80	7
87	80	81	7
88	81	82	7
89	82	83	7
90	83	84	7
91	84	85	7
92	85	86	7
93	86	87	7
94	87	88	7
95	88	89	7
96	89	90	7
97	90	91	10
98	91	91	7
Total weight			740

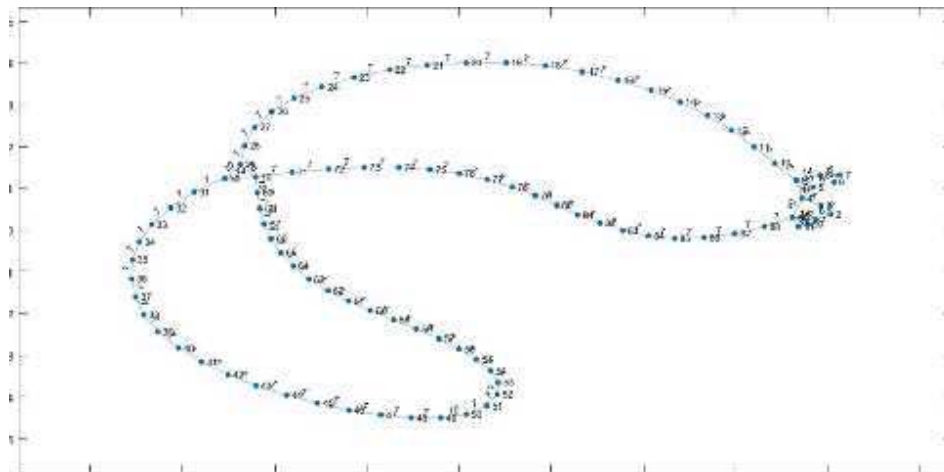


Figure 1. Grand Asia City Housing

From the figure numbers show houses, the numbers in lines show the distance between houses in meters.

3.1 User Interpace Program

At this stage, testing of the program has been done based on each algorithm. Testing on each algorithm is done by having the same treatment, that is using the same data in the form of graphs with 91 vertices.

From this testing, it will be known the complexity time required by each algorithm and also vertices connected in the form of solving the MST problem from the graph used

3.1.1 mImplementation of Prim's Algorithm to solve above problem

	Edge		Weight	Edge		Weight	Edge		Weight	Edge		Weight
1	1	2	8	74	75	7	25	26	7	51	50	7
2	2	3	6	75	74	7	26	27	7	50	50	10
3	3	4	6	74	73	7	27	28	7	50	51	7
4	1	90	10	73	72	7	28	29	7	51	52	7
5	90	91	7	72	71	7	29	30	10	52	53	7
6	4	5	10	71	70	7	30	31	7	53	54	7
7	5	6	6	5	9	10	58	57	7	54	55	7
8	6	7	6	9	10	7	57	56	7	55	56	7
9	7	8	6	10	11	7	56	55	7	56	57	7
10	4	85	10	11	12	7	55	54	7	57	58	7
11	85	88	7	12	13	7	54	53	7	58	59	7
12	88	87	7	13	14	7	53	52	7	59	60	7
13	87	86	7	14	15	7	52	51	7	60	61	7
14	86	85	7	15	16	7	51	50	7	61	62	7
15	85	84	7	16	17	7	50	49	7	62	63	7
16	84	83	7	17	18	7	49	48	7	63	64	7
17	83	82	7	18	19	7	48	47	7	64	65	7
18	82	81	7	19	20	7	47	46	7	65	66	7
19	81	80	7	20	21	7	46	45	7	66	67	7
20	80	79	7	21	22	7	45	44	7	67	68	7
21	79	78	7	22	23	7	44	43	7	68	69	7
22	78	77	7	23	24	7	43	42	7	69	70	7
23	77	76	7	24	25	7	42	41	7	70	71	7
24												
25												

1	Edge		Weight	Edge		Weight	Edge		Weight	Edge		Weight
2	1	2	6	76	75	7	25	26	7	51	50	7
3	2	3	6	75	74	7	26	27	7	29	30	10
4	3	4	6	74	73	7	27	28	7	30	31	7
5	1	90	10	73	72	7	28	29	7	31	32	7
6	90	91	7	72	71	7	29	30	10	32	33	7
7	4	5	10	71	70	7	30	31	7	33	34	7
8	5	6	6	5	9	10	31	32	7	34	35	7
9	6	7	6	9	10	7	32	33	7	35	36	7
10	7	8	6	10	11	7	33	34	7	36	37	7
11	4	89	10	11	12	7	34	35	7	37	38	7
12	89	90	7	12	13	7	35	36	7	38	39	7
13	90	91	7	13	14	7	36	37	7	39	40	7
14	91	92	7	14	15	7	37	38	7	40	41	7
15	92	93	7	15	16	7	38	39	7	41	42	7
16	93	94	7	16	17	7	39	40	7	42	43	7
17	94	95	7	17	18	7	40	41	7	43	44	7
18	95	96	7	18	19	7	41	42	7	44	45	7
19	96	97	7	19	20	7	42	43	7	45	46	7
20	97	98	7	20	21	7	43	44	7	46	47	7
21	98	99	7	21	22	7	44	45	7	47	48	7
22	99	100	7	22	23	7	45	46	7	48	49	7
23	100	101	7	23	24	7	46	47	7	49	50	7
24	101	102	7	24	25	7	47	48	7	50	51	7
25	102	103	7	25	26	7	48	49	7	51	52	7
26	103	104	7	26	27	7	49	50	7	52	53	7
27	104	105	7	27	28	7	50	51	7	53	54	7
28	105	106	7	28	29	7	51	52	7	54	55	7
29	106	107	7	29	30	7	52	53	7	55	56	7
30	107	108	7	30	31	7	53	54	7	56	57	7
31	108	109	7	31	32	7	54	55	7	57	58	7
32	109	110	7	32	33	7	55	56	7	58	59	7
33	110	111	7	33	34	7	56	57	7	59	60	7
34	111	112	7	34	35	7	57	58	7	60	61	7
35	112	113	7	35	36	7	58	59	7	61	62	7
36	113	114	7	36	37	7	59	60	7	62	63	7
37	114	115	7	37	38	7	60	61	7	63	64	7
38	115	116	7	38	39	7	61	62	7	64	65	7
39	116	117	7	39	40	7	62	63	7	65	66	7
40	117	118	7	40	41	7	63	64	7	66	67	7
41	118	119	7	41	42	7	64	65	7	67	68	7
42	119	120	7	42	43	7	65	66	7	68	69	7
43	120	121	7	43	44	7	66	67	7	69	70	7
44	121	122	7	44	45	7	67	68	7	70	71	7
45	122	123	7	45	46	7	68	69	7	71	72	7
46	123	124	7	46	47	7	69	70	7	72	73	7
47	124	125	7	47	48	7	70	71	7	73	74	7
48	125	126	7	48	49	7	71	72	7	74	75	7
49	126	127	7	49	50	7	72	73	7	75	76	7
50	127	128	7	50	51	7	73	74	7	76	77	7
51	128	129	7	51	52	7	74	75	7	77	78	7
52	129	130	7	52	53	7	75	76	7	78	79	7
53	130	131	7	53	54	7	76	77	7	79	80	7
54	131	132	7	54	55	7	77	78	7	80	81	7
55	132	133	7	55	56	7	78	79	7	81	82	7
56	133	134	7	56	57	7	79	80	7	82	83	7
57	134	135	7	57	58	7	80	81	7	83	84	7
58	135	136	7	58	59	7	81	82	7	84	85	7
59	136	137	7	59	60	7	82	83	7	85	86	7
60	137	138	7	60	61	7	83	84	7	86	87	7
61	138	139	7	61	62	7	84	85	7	87	88	7
62	139	140	7	62	63	7	85	86	7	88	89	7
63	140	141	7	63	64	7	86	87	7	89	90	7
64	141	142	7	64	65	7	87	88	7	90	91	7
65	142	143	7	65	66	7	88	89	7	91	92	7
66	143	144	7	66	67	7	89	90	7	92	93	7
67	144	145	7	67	68	7	90	91	7	93	94	7
68	145	146	7	68	69	7	91	92	7	94	95	7
69	146	147	7	69	70	7	92	93	7	95	96	7
70	147	148	7	70	71	7	93	94	7	96	97	7
71	148	149	7	71	72	7	94	95	7	97	98	7
72	149	150	7	72	73	7	95	96	7	98	99	7
73	150	151	7	73	74	7	96	97	7	99	100	7
74	151	152	7	74	75	7	97	98	7	100	101	7
75	152	153	7	75	76	7	98	99	7	101	102	7
76	153	154	7	76	77	7	99	100	7	102	103	7
77	154	155	7	77	78	7	100	101	7	103	104	7
78	155	156	7	78	79	7	101	102	7	104	105	7
79	156	157	7	79	80	7	102	103	7	105	106	7
80	157	158	7	80	81	7	103	104	7	106	107	7
81	158	159	7	81	82	7	104	105	7	107	108	7
82	159	160	7	82	83	7	105	106	7	108	109	7
83	160	161	7	83	84	7	106	107	7	109	110	7
84	161	162	7	84	85	7	107	108	7	110	111	7
85	162	163	7	85	86	7	108	109	7	111	112	7
86	163	164	7	86	87	7	109	110	7	112	113	7
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92	169	170	7	92	93	7	115	116	7	118	119	7
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94	171	172	7	94	95	7	117	118	7	120	121	7
95	172	173	7	95	96	7	118	119	7	121	122	7
96	173	174	7	96	97	7	119	120	7	122	123	7
97	174	175	7	97	98	7	120	121	7	123	124	7
98	175	176	7	98	99	7	121	122	7	124	125	7
99	176	177	7	99	100	7	122	123	7	125	126	7
100	177	178	7	100	101	7	123	124	7	126	127	7
101	178	179	7	101	102	7	124	125	7	127	128	7
102	179	180	7	102	103	7	125	126	7	128	129	7
103	180	181	7	103	104	7	126	127	7	129	130	7
104	181	182	7	104	105	7	127	128	7	130	131	7
105	182	183	7	105	106	7	128	129	7	131	132	7
106	183	184	7	106	107	7	129	130	7	132	133	7
107	184	185	7	107	108	7	130	131	7	133	134	7
108	185	186	7	108	109	7	131	132	7	134	135	7
109	186	187	7	109	110	7	132	133	7	135	136	7
110	187	188	7	110	111	7	133	134	7	136	137	7
111	188	189	7	111	112	7	134	135	7	137	138	7
112	189	190	7	112	113	7	135	136	7	138	139	7
113	190	191	7	113	114	7	136	137	7	139	140	7
114	191	192	7	114	115	7	137	138	7	140	141	7
115	192	193	7	115	116	7	138	139	7	141	142	7
116	193	194	7	116	117	7	139	140	7	142	143	7
117	194	195	7	117	118	7	140	141	7	143	144	7
118	195	196	7	118	119	7	141	142	7	144	145	7
119	196	197	7	119	120	7	142	143	7	145	146	7
120	197	198	7	120	121	7	143	144	7	146	147	7
121	198	199	7	121	122	7	144	145	7	147	148	7
122	199	200	7	122	123	7	145	146	7	148	149	7
123	200	201	7	123	124	7	146	147	7	149	150	7
124	201	202	7	124	125	7	147	148	7	150	151	7
125	202	203	7	125	126	7	148	149	7	151	152	7
126	203	204	7	126	127	7	149	150	7	152	153	7
127	204	205	7	127	128	7	150	151</				

- The minimum number of weights produced as an MST solution on the Prim's and Boruvka's algorithm are the same as 642 meters
- The number of edges formed after stretching trees is the same for both algorithms, that is 90 edges
- The time taken by each algorithm to complete MST is different, that is 0.0937 seconds for Prim's algorithm, and 0.78123 seconds for Boruvka's algorithm.

4. Conclusions

The Prim's and Boruvka's algorithm are algorithms used in solving MST problems. In Prim's algorithm, the minimum weight obtained is 642 meters by computing time of 0.0937 seconds. In the Boruvka's algorithm, the minimum weight obtained is 642 meters by computing time of 0.78123 seconds. From the two algorithms used, the prim's algorithm is more efficient.

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