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The 5th IMT - GT International Conference on Mathematics, Statistics and Their Applications

ICMSA 2009

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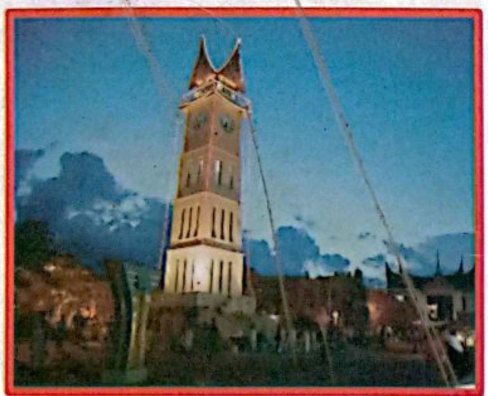
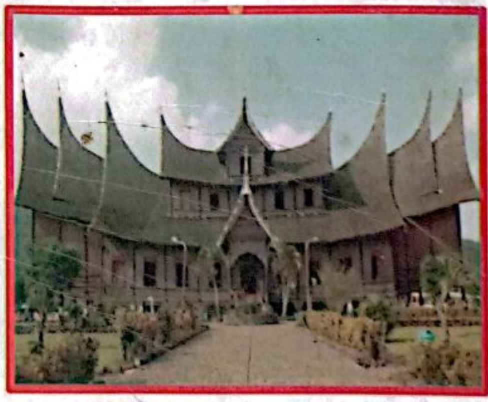
I Made Arnawa, Muhafzan, Maiyastri, Susila Bahri





Organized by :

June 9-11, 2009
The Hills Hotel
Bukittinggi, Indonesia

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June 2009

Preface

First of all, I would like to say welcome to Bukittinggi, Indonesia to all of you. It is an honour for us to host this conference. We are very happy and proud because the participants of this conference come from many countries; we have participants from Libya, Japan, Qatar, India, Malaysia, Singapore, Thailand, Iran, and many more.

Ladies and gentlemen, according to constructivism theory, mathematics comes out as a result of social construction; that's why, the outcomes of our researches in mathematics, like theorem or formula of mathematics, should be communicated in a scientific forum such as seminar or conference. Through this kind of seminar or conference, we could refine the existing theorems or we could get new ideas to produce a new one. Seminar or conference which is held annually enables us to continually develop the science of mathematics until the end of the time.

That's way, in this two-day conference, we are going to discuss around 250 papers coming from diverse aspects of mathematics ranging from analysis, applied mathematics, statistics, algebra, Computational Mathematics, mathematics education, and other related topics.

For all of us here, I would like to convey my endless appreciation and gratitude for your participation in this conference.

Thank you very much

Dr. I Made Arnawa
Chairman of the Conference

Message from Rector Andalas University

It gives me great pleasure to extend my sincere and warm welcome to the participants of the 5th International Conference on Mathematics Statistics and Application (The IMT GT's 5th ICMSA 2009) - A Joint Scientific Program organized by Universities over Indonesia, Malaysia and Thailand Growth Triangle Region. On behalf of Andalas University, let me welcome all of you to the conference in Bukittinggi, West Sumatra Province, the land of Minang kabau.

We believe that from this scientific meeting, all of participants will have time to discuss and exchange ideas, findings, creating new networking as well as strengthen the existing collaboration in the respective fields of expertise. In the century in which the information is spreading in a tremendous speed and globalization is a trend, Andalas University must prepare for the tough competition that lay a head. One way to succeed is by initiating and developing collaborative work with many partners from all over the world. Through the collaboration in this conference we can improve the quality of our researches as well as teaching and learning process in mathematics and to achieve standards and requirements applied in many developed countries. I strongly believe that this conference is and extraordinary testimony to our capacity building at international, regional and local level.

I would like to express my deep gratitude to International Scientific Committee of who has honored the Mathematics Department, Faculty of Mathematics and Natural Sciences, Andalas University to host this prestigious conference. This is a very special opportunity for us to be involved in a regional community of knowledgeable scientist in the field of mathematics, statistics and their applications. I would also like to extend my gratitude to keynote speakers, participants, and organizer of this conference for their contribution to this event. My special thank is also rendered to the local government of West Sumatra for various supports and facilities.

Finally I wish all participants a fruitful deliberation at the conference. I also wish all participants and accompanying spouses a pleasant and enjoyable stay in Bukittinggi City, West Sumatra.

Prof. Dr. Ir. Musliar Kasim, MS
Rector

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Contents

CONTENTS

Arranging The Examination Schedule By Using Graph Coloring Algorithm

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Abstract

One of the applications related to graph is the graph coloring. Graph coloring consist of vertices, edges and domain coloring. In this writing, the writer specifically discusses the vertices coloring. The vertices coloring is theapplication of colors to the vertices of a graph in such a way so that there are no adjacent vertices have similar color. This method can be implemented in arranging the examination schedule, and then the minimum time in conducting examination can be achieved.

Keywords : graph, graph coloring, vertices coloring, vertices, edge.

1. Introduction

The proportional schedule setting palys a signifucant role in the smooth operation of the intitution and organization activities. A proportional schedule should consider all aspects affecting the schedule. The difference of aspects affecting the schedule may affect the result of the schedule.

The problems in arranging the examination Schedule that needs to be solved may affect the creation of an examination Schedule, such as: the linitation of time, and the students who takes different subjects in different semester. Sometimes, in one shift of examination, there is only one examination Schedule taking place, thus in a semester with many allocation of subjects may take a long examination time to finish.

In mathematics perspective, the arrangement of examination Schedule can be tackled by using the graph coloring algoritm, so an affective examination Schedule can be produced and it assures there will no students who takes two or more subjects have examination Schedule in the same time. Based on this algoritm, a simple application program can be made by processing the data input of the examination Schedule, the students taking the subjects, and in the ends it results the intended proportional Schedule.

The objective of this thesis is to arrange an examination schedule and suggests the steps involved in arranging the examination schedule by using the vertecs coloring algorithm in graph and the steps of vertices coloring by using the pascal programming language, which then can be applied in Borland Delphi 7.

2. The Background of the Theory

The graph theory has been an old theory but has many implementations util today. Graph is used to present the descrit objects and therelation among those objects. The visual representation of a graph is by stating objects with a dot or vertecs, while the relation among objects is stated in the forms of lines or edge.

Graph $G=(V,E)$ consists of the finite compilation of dots or vertecs(*vertices*) $V=\{v_1,v_2,...\}$ with $V\neq\phi$, is noted as $V(G)$ and finite compilation edges $E=\{e_{11},e_{12},...,e_{ij},...\}$, is noted as $E(G)$. The edge e_{ij} is identified as the compilation of a series of pair of vertices (v_i,v_j). The vertice of v_i and vertice of v_j in a mutual accord with the edge e_{ij} are called the tip points of e_{ij}. Loop is the edge of vertices with the same tip points. The finite graph is a graph with the finite compilation of vertices.

The simple graph is a graph with the absence of loopand parallel edges. For example v is a vertice, and e is an edge of a graph. If $e=vv_0$ with v_0 as other vertice of the graph, then vertice v is called incidental to the edge *e*, and the edge *e* is called incidental with vertice v.

Two vertices v_i and v_j in graph G is called adjacent if and if only the two vertices from thesame edges, which are e_{ij} or $v_iv_j\in E$. The vertices degree of v_i in graph G, noted as $d(v_i)$ is the number of related edges with v_i, or the number of vertices that is adjacent with v_i. Then the degree of loop is counted twice.

The G is stated as connected graph if each of the two vertices in G graph has the connected trajectory. The Adjacency Matrices [7], for example $G = (V, E)$ is a graph with vetice m, for example: $v_1, v_2, \ldots, v_m$. Then the adjacency for this graph is in the form :

$$\begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1m} \\ a_{21} & a_{22} & \cdots & a_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mm} \end{pmatrix}$$

Where the element a_{ij} in line -*i* and colomn -*j* have the value of 1 if the vertices -*i* is adjacent with vertices -*j*, with the value 0 for others.
For all the adjacency matrices of the simple graph is the symmetrical matrices or $a_{ij} = a_{ji}$, for every *i* and *j*, where a_{ij} symbolize the element of line -*i* and column -*j*.

The defenition of graph coloring according to [3] is the application of colors which are usually represented as series of numbers starting from 1, in a certain object of a graph. The objects may appear in the form of dots, edges, domain or the combination of those three.

The colouring problem can be described in graph *G* with n vertices ready to be colored, where there are no two adjacent verteices have a same color. Then, the vertices with the same color are grouped in one compilation, called partitioning problem. Classification can be done to the vetices or the edges of a graph.

The coloring of a simple graph G is the application of every vertices in G where there are no adjacent vertices have the same colors. The number of the smallest color is needed to color the graph so that there are no two adjacent vertices the same colors and it is called chromatic number of the graph, symbolized as $\chi(G)$.

In this writing, the writer only discusses the problem of scheduling, so the topic disscused futher is only about the vertices coloring.

The Guidelines of Vertices Coloring in Graph are :

For example the graph $G = (V, E)$ is a graph with n verteks which is $v_1, v_2, \ldots, v_n$. Then the steps in the vertices coloring of a graph are :

1. Organize vertices $v_1, v_2, \ldots, v_n$ from the highest degree to the lowest degree. For example the organization of vertices obtained from the highest degree to the lowest degree is $v_1', v_2', \ldots, v_n'$.
2. Start fro the verteices with the highest degree, for example vertice v_1'. Apply any color to the vertice v_1', for example color 1.
3. The application of the color to the vertice v_2' is done in a way if vetice v_2' is connected with vertice v_1', then apply different color to v_2' from the color of vertice v_1'.
4. For $i = 3, 4, \ldots, n$, apply the coloring of vertice v_i', by comparing the vertice v_i' with all the colored vertices. If vertices v_i' is connected to vetices v_n', then the color applied to the vertices should be different from the color of vertice v_n'.
5. The coloring of vertices in graph can be done by using the adjacency matrices. Based on the adjacency matrices, the graph coloring cann be implemented with the guidelines as follows:
   a. If $a_{ij} = 1$ or vertices is connected with vertices v_j, then the color of vertice should be different from the color of vertice v_j
   b. If $a_{ij} = 0$ or vertice v_i is not connected to the vertice v_j, then the color of vertice v_i can be similar to the color of vertice v_j

3. The Arrangement of Examination Schedule

In the mathematics department of Mathematics and science Faulty of Universitas Andalas, for the academic year of 2008/2009 there 45 required subjects and 15 optional subjects, listed as foolows :
The Required Subjects :

$$A=\begin{bmatrix}
0&1&1&1&1&1&1&1&1&1&0&0&0&1&1&1&0&0&0&0&0&0\\
1&0&1&1&1&1&1&1&1&1&0&0&0&1&1&1&0&0&0&0&0&0\\
1&1&0&1&1&1&1&1&1&1&1&1&1&1&1&1&1&1&1&1&0&0\\
1&1&1&0&1&1&1&1&1&1&0&0&0&1&1&1&0&0&0&0&0&0\\
1&1&1&1&0&1&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0\\
1&1&1&1&1&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0\\
1&1&1&1&0&0&0&1&1&1&1&1&1&1&1&1&1&1&1&1&1&1\\
1&1&1&1&0&0&1&0&1&1&1&1&1&1&1&1&1&1&1&1&0&0\\
1&1&1&1&0&0&1&1&0&1&0&0&0&1&1&1&0&0&0&0&0&0\\
1&1&1&1&0&0&1&1&1&0&1&1&1&1&1&1&1&1&1&1&0&0\\
0&0&1&0&0&0&1&1&0&1&0&1&1&1&1&1&1&1&1&1&1&1\\
0&0&1&0&0&0&1&1&0&1&1&0&1&1&1&1&1&1&1&1&1&1\\
0&0&1&0&0&0&1&1&0&1&1&1&0&1&1&1&1&1&1&1&1&1\\
1&1&1&1&0&0&1&1&1&1&1&1&1&0&1&1&1&1&1&1&0&0\\
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0&0&1&0&0&0&1&1&0&1&1&1&1&1&1&1&0&1&1&1&1&1\\
0&0&1&0&0&0&1&1&0&1&1&1&1&1&1&1&1&0&1&1&0&0\\
0&0&1&0&0&0&1&1&0&1&1&1&1&1&1&1&1&1&0&1&1&1\\
0&0&1&0&0&0&1&1&0&1&1&1&1&1&1&1&1&1&1&0&1&1\\
0&0&0&0&0&0&1&0&0&0&1&1&1&0&0&0&1&0&1&1&0&1\\
0&0&0&0&0&0&1&0&0&0&1&1&1&0&0&0&1&0&1&1&1&0
\end{bmatrix}$$

The degree of each vertices is obtained from the number of other vertices that are connected to those vertices or by calculating the edges element or the column of adjacency matrices, with the result as follows :

Verteks	Derajat	Verteks	Derajat
1	12	12	15
2	12	13	15
3	19	14	17
4	12	15	17
5	5	16	17
6	5	17	15
7	19	18	13
8	17	19	15
9	10	20	15
10	17	21	8
11	15	22	8

Based on the guidellines and sampling above, an adjacency matrices can be made with the series matrices that are organized from the highest degree to the lowest degreewith the dimension of 22×22, as shown follows :

	V_3	V_7	V_8	V_{10}	V_{14}	V_{15}	V_{16}	V_{11}	V_{12}	V_{13}	V_{17}	V_{19}	V_{20}	V_{18}	V_1	V_2	V_4	V_9	V_{21}	V_{22}	V_5	V_6
V_3	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1
V_7	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
V_8	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
V_{10}	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
V_{14}	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
V_{15}	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
V_{16}	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
V_{11}	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	0	0	0	1	1	0	0
V_{12}	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	1	1	0	0
V_{13}	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	0	0	0	1	1	0	0
V_{17}	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	0	0	0	1	1	0	0
V_{19}	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	0	0	1	1	0	0
V_{20}	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	0	1	1	0	0
V_{18}	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
V_1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	0	0	1	1
V_2	1	1	1	1	1	1	1	0	0	0	0	0	0	0	1	0	1	1	0	0	1	1
V_4	1	1	1	1	1	1	1	0	0	0	0	0	0	0	1	1	0	1	0	0	1	1
V_9	1	1	1	1	1	1	1	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0
V_{21}	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	1	0	0
V_{22}	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	1	0	0	0
V_5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	1
V_6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	1	0

Based on the adjacency matrices stated above, the coloring of the vertices can be implemented as follows :

1. For example v_3 is colored with the color no. 1.
2. The vertices v_7 is connected with vertices v_3, then the coloring of vertices v_7 can not be in the similar color to the vertice v_3. For example, the vertice v_7 is colored with the color no. 2.
3. The vertice v_8 is connected with vertices v_3 and v_7, then the color of vertice v_8 can not be similar with the color of the vertice v_3 and v_7. For example, the vertice v_8 is colored with the color no. 3.
4. The vertice v_{10} is connected with the vertices v_3, v_7 and v_8, then the color of vertices v_{10} can not be similar to the color of vertice v_3, v_7 and v_8. For example, the vertice v_{10} is colored with the color no. 4.
5. The vertice v_{14} is connected with the vertices v_3, v_7, v_8 and v_{10}, then the color of vertice v_{14} can not be in similar color with vertices v_3, v_7, v_8 and v_{10}. For example, the vertice v_{14} is colored with the color no. 5.
6. The vertice v_{15} is connected with vertices v_3, v_7, v_8, v_{10} and v_{14}, then the color of vertice v_{15} can not be in similar color with the color of vertices v_3, v_7, v_8, v_{10} and v_{14}. For example vertice v_{15} is colored with color no.6.
7. The vertice v_{16} is connected with vertices v_3, v_7, v_8, v_{10}, v_{14} and v_{15}, then the color of vertice v_{16} can not be similar to the color of vertices v_3, v_7, v_8, v_{10}, v_{14} and v_{15}. For example, vertice v_{16} is colored with color no. 7.
8. The vertice v_{11} is connected to the vertices v_3, v_7, v_8, v_{10}, v_{14}, v_{15} and v_{16}, then the coloring of vertice v_{11} can not be similar with the color of vertices v_3, v_7, v_8, v_{10}, v_{14}, v_{15} and v_{16}. For example vertice v_{11} is colored with color no. 8.
9. The vertice v_{12} is connected with vertices v_3, v_7, v_8, v_{10}, v_{14}, v_{15}, v_{16} and v_{11}, then the color of vertice v_{12} cannot be similar to the color of vertices v_3, v_7, v_8, v_{10}, v_{14}, v_{15}, v_{16} and v_{11}. For example, vertice v_{12} is colored with color no. 9.
10. The vertice v_{13} is connected with vertices v_3, v_7, v_8, v_{10}, v_{14}, v_{15}, v_{16}, v_{11} and v_{12}, then the color of vertice v_{13} cannot be similar to the that of vertices v_3, v_7, v_8, v_{10}, v_{14}, v_{15}, v_{16}, v_{11} and v_{12}. For example, vertice v_{13} is colored with color no. 10.
11. The vertice v_{17} is connected with the vertices v_3, v_7, v_8, v_{10}, v_{14}, v_{15}, v_{16}, v_{11}, v_{12} and v_{13}, then the color of vertice cannot be in the similar color to the vertices v_3, v_7, v_8, v_{10}, v_{14}, v_{15}, v_{16}, v_{11}, v_{12} and v_{13} , so vertice v_{17} is colored with color no. 11.
12. The vertice v_{19} is connected to the vertices v_3, v_7, v_8, v_{10}, v_{14}, v_{15}, v_{16}, v_{11}, v_{12}, v_{13} and v_{17}, then the color of the vertices v_3 can not be in the similar color with that of vertices v_3, v_7, v_8, v_{10}, v_{14}, v_{15}, v_{16}, v_{11}, v_{12}, v_{13} and v_{17}. For example, vertice v_{19} is colored with color no. 12.
13. The vertice v_{20} is connected with vertices v_3, v_7, v_8, v_{10}, v_{14}, v_{15}, v_{16}, v_{11}, v_{12}, v_{13}, v_{17} and v_{19}, then the color of vertices v_{20} cannot be in the similar color to that of vertices v_3, v_7, v_8, v_{10}, v_{14}, v_{15}, v_{16}, v_{11}, v_{12}, v_{13}, v_{17} and v_{19}. For example, vertice v_{20} is colored with color no. 13.
14. The vertice v_{18} is connected with vertices v_3, v_7, v_8, v_{10}, v_{14}, v_{15}, v_{16}, v_{11}, v_{12}, v_{13}, v_{17}, v_{19} and v_{20}, then the color of vertice v_{18} cannot be similar to the color of vertices v_3, v_7, v_8, v_{10}, v_{14}, v_{15}, v_{16}, v_{11}, v_{12}, v_{13}, v_{17}, v_{19} and v_{20}. For example, the color of vertice v_{18} is colored with color no 14.
15. The vertice v_1 is connected to the vertices v_3, v_7, v_8, v_{10}, v_{14}, v_{15}, and v_{16}. Then the color of vertice v_1 cannot be in similar color to that of vertices v_3, v_7, v_8, v_{10}, v_{14}, v_{15}, and v_{16}, but vertice v_1 is not connected to vertice v_{11} so vertice v_1 is colored with the same color with the color of vertice v_{11} which is the color no. 8.
16. The vertice v_2 is connected to the vertices v_3, v_7, v_8, v_{10}, v_{14}, v_{15}, and v_{16}, then the color of vertice v_2 cannot be similar to the color of vertices v_3, v_7, v_8, v_{10}, v_{14}, v_{15}, and v_{16}. Vertice v_2 is not connected to vertice v_{11}, because vertice v_{11} has the similar color to the color of vertice v_1 and vertice v_1 is connected to vertice v_2, then the color of vertice v_2 cannot be in similar color to the color of vertice v_1. Vertice v_2 is not connected to vertice v_{12}, then the color of vertice can be similar to the color of vertice v_{12}, which is color no. 9.
17. The vertice v_4 is connected to vertices v_3, v_7, v_8, v_{10}, v_{14}, v_{15}, and v_{16}, then the color of vertice v_4 cannot be similar with the color of vertices v_3, v_7, v_8, v_{10}, v_{14}, v_{15}, and v_{16}. Vertice v_4 is not connected to vertice v_{11}, because vertice v_{11} has similar color to the color of vertice v_1 and vertice v_1 is connected to vertice v_4, so the color of vertice v_4 cannot be the same with the color of vertice v_{11}. The vertice of v_4 is not connected to vertice v_{12}, because vertice v_{12} is in the similar color with vertice v_2 and vertice v_2 is connected to vertice v_4, then the color of vertice v_4 cannot be in similar color with the color of vertice v_{12}. Vertice v_4 is not connected to vertice v_{17} then the color of vertice v_4 can be in similar color with the color of vertice v_{17}, which is the color no. 10.
18. The vertice v_9 is connected to vertices v_3, v_7, v_8, v_{10}, v_{14}, v_{15}, and v_{16}, then the color of vertice v_9 can not be similar to that of vertices v_3, v_7, v_8, v_{10}, v_{14}, v_{15}, and v_{16}. Vertice v_9 is not connected to vertice v_{11}, because vertice v_{11} has a similar color with the color of v_1 and vertice v_1 is connected with vertice v_9, then the color of vertice v_9 can not be in similar color to vertice v_1. Vertice v_9 is not connected to vertice v_{12}, but, because vertice v_{12} has similar color to the color of vertice v_2 and vertice v_2 is connected to vertice v_9, then the color of vertice v_9 cannot be in similar color to the color of vertice v_{12}. Vertice v_9 is not connected to vertice v_{13}. Because vertice v_{13} has similar color to the color of vertice v_3 and vertice v_3 is connected to vertice v_9, then the color of vertice v_9 cannot be similar to the color of vertice v_{13}. Vertice v_9 is not connected to vertice v_{17}, because vertice v_{17} has similar color with vertice v_4 and vertice v_4 is connected with v_9 then the color of vertice v_9 cannot be in similar color with that of verice v_{17}. Vertice v_9 is not connected to vertice v_{19} , so vertice is in the color no. 11.

19. The vertice v_{21} is not connected to vertice v_3, then the color of vertice v_{21} can have similar color to vertice v_3 so vertice v_{21} has color no. 1.
20. The vertice v_{22} is not connected to vertice v_3, because vertice v_3 has similar color to vertice v_{21} and vertice v_{21} is connected to vertice v_{22}, then the color of vertice v_{22} cannot be similar to the color of vertice v_3. Vertice v_{22} is not connected to vertice v_8, then the color of vertice v_{22} can have the same color with vertice v_8 so the color of vertice v_{22} is color no.3.
21. The vertice v_5 is connected to vertice v_3, so the color of vertice v_5 cannot be the same with the color of vertice v_3. Vertice v_5 is not connected to vertice v_7, then the color of vertice v_5 can be similar to the color of vertice v_5, and the color is color no.2.
22. The vertice v_6 is connected to vertice v_3, so the color of vertice v_6 cannot be similar to the color of vertice v_3. Vertice v_6 is not connected to vertice v_7. Since vertice v_7 has similar color to vertice v_5 and vertice v_5 is connected to vertice v_6 then the color of vertice v_6 cannot be similar to the color of vertice v_7. Vertice v_6 is not connected to vertice v_8, so the color of vertice v_6 can be similar to the color of vertice v_8, which is the color no.3.

Based on the graph coloring guidelines described above, there are 14 colors applied. This means there are 14 shifts of examination, as explained below :

Warna	Verteks
1	v_3, v_{21}
2	v_5, v_7
3	v_6, v_8, v_{22}
4	v_{10}
5	v_{14}
6	v_{15}
7	v_{16}
8	v_1, v_{11}
9	v_2, v_{12}
10	v_4, v_{13}
11	v_9, v_{17}
12	v_{19}
13	v_{20}
14	v_{18}

Therefore, from the table, we can organize the examination shift then there is no students following more than 1 examination at the same time. The schedule is listed as follow :

SHIFT	COURSE LIST	NAME OF COURSES
1	3 21	Kalkulus II Geometri
2	5 7	Pend. Kewarganegaraan Statistika Matematika I
3	6 8 22	Konsep Teknologi Kalkulus Peubah Banyak Pengendalian Mutu
4	10	Metode Numerik
5	14	Statistika Komputasi
6	15	Statistika Non Parametrik
7	16	Pemograman Linier
8	1 11	Statistika Elementer Analisis II
9	2 12	Pengenalan Aplikasi Komputer Aljabar I
10	4 13	Fisika Dasar II Matematika Demografi
11	9 17	Pemograman Komputer II Rancangan Percobaan
12	19	Aktuaria
13	20	Permasalahan Nilai Batas
14	18	Kontrol Optimal

4. Conclusion

The use of algorithm in the vertices coloring algoritm can be implemented as an application program used to solve the graph coloring such as in the examination examination schedule.

If the process of schedule arrangement is carried out manually, it will take a long time and careful effort. Thus, the application coloring program enables a faster and simpler method of coloring with minimum human error.

By implementing this program application, we are enabled not only in organizing the examination schedule but also in modifying other problems that can be solved by using the algorithm verticee coloring for graph.

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