

Knowing group motivation using Bolzano method on PageRank computation

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ABSTRACT

On the e-learning system, student assignments are collected, but problems arise that based on observations from two classes of database courses, 73% of students make plagiarism so lecturers need to give motivation to students. Self motivate is needed by with a group of students. For this reason, using a bolzano method or bisection method will provide an overview of the development of the plagiarism trend between groups of students based on scores on similarity score that compute by PageRank algorithm used by Google. Research method is carried out by conducting preliminary observations of plagiarism scores and creating markov matrix. PageRank compute this ranking and Bolzano method find the intersection of two eigenvalues. Bolzano results the maximum and minimum values on range of intervals where each group consists of 5 students. Experiments were conducted in 3 classes of database courses. Trend analysis found that the plagiarism score averaged 54% with a gradient of 3°, this is relatively small but when spread in different groups it becomes larger and student group have a higher plagiarism score. Results implies a way of looking student motivation based on the plagiarism score by a small group to motivate each other.

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1. INTRODUCTION

The use of technology in education has begun since the era of 2000 until the industrial revolution 4.0 has become an important part of the education process. The educational process on campus requires students to be active and creative, where exam questions have directed questions that are analytical and synthesized. Material and questions of this type of analysis provide new directions in achieving material to deal with increasingly rapid technological change. This technology brings quite a lot of benefits, but sometimes convenience brings bad things, for example in lectures, students easily plagiarize their assignments so that lecturers need to provide more motivation so that students become more creative.

Plagiarism has an adverse effect on students regarding honesty in the learning process. The e-learning system has used plagiarism detection, the result of which is a score of similarity between friends in current campus, this score does not give any decision, only used as a reference for lecturers that students have committed violations. Lecturers need a tool to analyze the score, so this research appears with the aim of helping lecturers look for similarities and trends in plagiarism scores in one class or small group so students can motivate themselves and their friends.

This research has objectives, namely: 1) designing markov matrices to be processed with the PageRank algorithm, 2) calculating ranking results based on the markov plagiarism score using the Bolzano Method on PageRank, and 3) determining the validity of the results by conducting trend analysis. To achieve this goal, a method that is in accordance with this research is used. The initial stages in this research depend on the correct design of the Markov matrix according to the first objective of the study. If the matrix is correct, then the next job will be easier to do. The achievement of each research objective will be included in the conclusions of this study.

1.1. Creativity on learning

According to Beghetto [1], the researcher introduces a new creative learning model that has the potential to support the development, adaptation, new planning, collaboration between researchers and educators as the focus of the research. Besides creativity is important for one's understanding of the problem. He is agree that intelligence has impact on creativity. Good understanding makes it easy for someone to understand their environment.

Spektor and Beenen [2] conduct a theory test that aims to find out how learning and its purpose are able to motivate students to create useful and current products. Trials have been carried out on 189 people who described an increase in thinking intelligence. Simultaneous work can improve novelty and creativity in an organization.

Successful factor of creativity on learning also discussed by Beghetto and Schreiber [3]. Creativity arises because of the weakness of students in the form of a situation that is not good, failure, doubt about something. Researchers try to give a picture of creativity raised every day in learning in the school environment. But it is not clearly stated how to motivate students based on the same case.

Reeve [4] discusses the benefits of learning and teaching with a method approach known as embodied creativity in academic writing using techniques adapted from the practice of art and design. The concept of creativity is discussed in connecting body and mind, learning environment, emotional role, new connection and reflection. This article provides convenience that it turns out that emotions can be influenced by connected environmental factors such as a vector.

Another research by Matusov and Shane [5] the basic concept of creativity currently requires an old concept that is not in accordance with the present conditions for it to be built a new concept of creativity that is able to solve the problem that is aimed at addressive, existential, axiological, and cultural. This article mentions the influence of culture in creativity which is quite interesting to be associated with certain regional conditions. Several countries, including Indonesia, have diverse cultures so that creativity becomes more diverse. The resulting creativity still carries local cultural values so that cultural sustainability is maintained and new uterine creativity emerges.

1.2. Plagiarism

Everyone has made plagiarism, but with different levels. Ferro and Martins [6] said that people do plagiarism because of the desire to succeed. Usually they are taking other people's ideas and using them they can be called 'thieves'. The researcher creates a new framework for defining academic plagiarism with a wider scope by producing a standard form.

Another reason for doing academic plagiarism observed by Šprajc *et al.* [7] conducted a survey of 17 faculties at the Maribor University, Slovenia. The methodology is using questionnaires with 95 closed questions giving results in the form of information on student motivation in learning influenced by plagiarism on campus. The results is no relationship between the duration of time online and plagiarism.

Plagiarism trends occur in several countries, one of which is India which is examined by Juyal *et al.* [8] describes plagiarism is the third largest crime in the world of research. In India plagiarism is under pressure to publish on campus so scientific writing ethics training is needed. In addition, the researcher said that a database of all articles is needed to be prevented by an early plagiarism detection system.

Plagiarism arises because the knowledge in citation is lacking, this is examined by Kauffman and Young [9], the study was conducted at undergraduate students in writing essays with two experiments namely using copy-paste or not at all. The results show that 79.5% of authors plagiarized digitally. this is due to an opportunity to do so, but when the text is converted into an image, the tendency will decrease.

Bates *et al.* [10] describes that academic honesty is important, but if dishonest students are still an ambiguous statement, whether students violate school rules or not. the role of technology makes it easier to plagiarize with various assistance such as Google. research results in an awareness of student behavior by evaluating the rules that are academically dishonest.

1.3. Self motivation

Motivation is needed by students to learn independently. Duffy and Azevedo [11] conducted research on 83 students randomly in learning sessions with a duration of 1 hour. The results of the analysis with multivariate analysis of covariance (MANCOVA) revealed that students who were smart and fast in

giving feedback turned out to spend time on independent learning. This was related to motivation to learn independently.

Mukhtar *et al.* [12] describes that research was conducted on workers in the health sector. Research discuss about the importance of self motivation in the educational literature. The results of the study revealed that the strategy of using the self-regulated learning method (SRL) helped several people to improve their self-motivation for the better.

Another research about self motivation conducted by León *et al.* [13], his article is to improve the field of mathematics education in the remainder. Using a sample of 1412 students, giving results namely the atmosphere in the classroom. Teachers who always provide support turned out to have a major influence in motivating students independently even though the subjects were boring or difficult.

Cho and Heron [14] was conducted a research on remedial mathematics by online with 229 students involved, giving results that emotions and strategies to motivate oneself did not give good results, students in online examinations did not get motivated because the role of the teacher was very important in learning. This article is very interesting because it explains that the teacher cannot be replaced by a machine. The teacher gives a legacy of good character for his students to adopt.

1.4. Regression

Regression as a part of interpolation has usefull way to predict the future trend. Meurer and Tolles [15] conducted research on pediatric patients with initial variables totaling 46 variables. Researchers use logistic regression to predict opportunity values and then analyze the results. Each prediction cannot provide accurate results but approaches in a better way.

Imai *et al.* [16] conducted an experiment on a dataset of cases of cholera. The case implied by flooding in Bangladesh. Another case is influenza and temperatures changes in Japan. Using regression based on time parameters results that dependence on the spread of disease in the weather.

Another discussion on regression conducted by Cleveland *et al.* [17] this regression model provides functions that correspond to the sample data provided. The study provides an explanation of diagnostic methods, which begin with each part of the data, the regression model, and until the development of the regression model. Several factors that influence are distribution, variance, linear or quadratic, and distribution size.

Knofczynski and Mundfrom [18] shows that using multiple regression, the minimum sample size is important for analyzing the results. Some samples have been tested which produce errors according to the sample size, if the sample is good even though the number can give a small error, and vice versa. The simulation in this study uses the Monte Carlo method. Liniear regression formula show by Darlington and Hayes [19] as:

$$b_1 = \frac{\sum_{i=1}^N x_i y_i}{\sum_{i=1}^N x_i^2} \quad (1)$$

$$b_0 = \bar{Y} - b_1 \bar{X} \quad (2)$$

$$Y = b_0 + b_1 X \quad (3)$$

Y value is obtained by determining the independent variable X and the constants b_0 and b_1 , the formula Y is expressed as simple linear regression.

1.5. Bolzano method

Bolzano method is often called bisection method is a method of determining the root by doing iteration until convergent. This method guarantees that the roots can be found in an interval if the function value is different from the sign, which is positive and negative. The Bolzano method provides certainty of convergence, this is different from the PageRank algorithm using power iteration whose convergence cannot be ascertained, but several markov matrix converges in quite a long time, compared to the size of the matrix. A journal that discusses this method in determining eigenvalues is to use a non-linear matrix. This algorithm can localize every problem in determining eigen values [20]. Bolzano theorem said that: *if* $f: [a, b] \subset \mathbb{R} \rightarrow \mathbb{R}$ is a continuous function and if it is holds that $f(a)f(b) < 0$, then there is at least one $x \in (a, b)$ such that $f(x) = 0$ [21].

1.6. PageRank

PageRank is an algorithm used in the Google search engine. This algorithm gives a democratic ranking based on the contribution of each node [22]. Berkhout [23], has done ranking optimization, one of which is the ergodic projector on the Markov matrix which contains the probability of the nodes so that this new approach is expected to accelerate convergence. PageRank definition by Sugihara [24] said that:

definition: a semi path is a collection of distinct nodes v_1, v_2, \dots, v_n together with $n - 1$ links, one from each v_1v_2 or v_2v_1, v_2v_3 or $v_3v_2, \dots, v_{n-1}v_n$ or v_nv_{n-1} . Which is every nodes connected minimum with itself and has a weight by scalar probability.

2. RESEARCH METHOD

The research method uses several stages starting from processing the plagiarism score in the database which is done by processing student answers to get a plagiarism score. The next step is computing ranking and implement Bolzano method inside PageRank algorithm which is done using Matlab software. The last step is the validation of the results to see the truth of the results of using the method in research to achieve research objectives.

2.1. Getting plagiarism score

The first step is to get the student plagiarism score in the database [25], the score has been calculated by the e-learning system when students work on the practice questions on the previous exam. The value is then processed by sorting from the smallest score to the largest, then calculating whether the number of scores exported by the application matches the number of students taking the exam. In taking data of 186 students had a plagiarism score.

	A	B	C
1	number	idstudent	plag_score
2	1	711	64
3	2	712	84
4	3	713	65
5	4	714	87
6	5	715	80
7	6	716	62
8	7	717	32
9	8	718	61
10	9	719	75
11	10	720	17
12	11	721	71

Figure 1. Student id and plagiarism score from database

Calculation of probability values in the Markov matrix uses Matlab, data from Figure 1 are then imported into Matlab.

2.2. Plagiarism score analysis with five-basic statistics

The plagiarism score obtained in the excel format is then processed with statistics to find the minimum value, maximum, mean, mode, variance. Processing is done with the help of an excel application that is quite easy to do, the result is a plagiarism score that has a minimum value of 2.3%, a maximum value of 98%, a mean of 59.9%, and a deviation of 16.94%. The calculation results in Figure 2 are used to see the behavior of the dataset.

C	D	E	F
plag_score	variance	stdev	mean
43	287.2909	16.94966	59.90909
57			
84			
39			
76			
60			

Figure 2. Simple statistic descriptive of dataset

2.3. PageRank computation

In ranking calculations, the researchers did it on Matlab with the windows operating system using a computer with 32 GB RAM, 4 GB GPU, and core 10 processor specifications. Figure 3 shows the calculation process up to the ranking results. The calculation in Figure 3 gives the results in a “.txt” file containing the probability of each node, the results can be seen in Figure 4. The calculation results in Figure 4 will then be used in ranking calculations which can be seen in Figure 5. The results of the ranking calculation are in the form of a “.txt” file containing the eigenvalues of the corresponding nodes.

```
Command Window
=== begin process... ===
Load dataset into memory : 1.154142 second
Dataset name : campus.txt
Number of edges : 24186 edges
Number of nodes (unique): 3286 nodes
Probability computation time(s): 0.006605 second
...writing file..
Saved to file in 0.241367 second
=== end process ===
fx >> |
```

Figure 3. Computing probability of each nodes

7.1880000e+03	1.0000000e+00	1.0000000e+00
4.3000000e+02	1.0000000e+00	1.1111111e-01
3.1340000e+03	1.0000000e+00	2.5000000e-01
3.0260000e+03	1.0000000e+00	1.0000000e+00
3.0100000e+03	1.0000000e+00	1.0000000e+00
8.0400000e+02	1.0000000e+00	1.4285714e-01
1.6000000e+02	1.0000000e+00	1.0000000e-01
9.5000000e+01	1.0000000e+00	8.1967213e-03
3.7700000e+02	1.0000000e+00	2.5000000e-01
8.8800000e+02	1.0000000e+00	2.0000000e-01
8.9000000e+01	1.0000000e+00	2.1739130e-02
1.9010000e+03	1.0000000e+00	1.0000000e+00
1.6100000e+02	1.0000000e+00	2.7777778e-02

Figure 4. Result of probability each nodes

```
Command Window
>> [u,p]=loadmat('dataset_with_prob.txt',2);
matrix size = 7604, nnz = 24186, zero cols = 4318
took 0.758718 seconds
>> rayleigh(p);

Metode Perhitungan : Power Method
Ukuran Matrik Markov : 7604
Nilai Alpha : 8.5000000e-01
Batas Epsilon : 1.000000000e-08
Nilai Galat : 0.000000000e+00
Waktu Eksekusi : 2.8372340637251975380139779048249693005346e-03
Jumlah Iterasi : 2
Estimasi Eigen Dominan : 1.0000000000000000000000000000000000000000000e+00
Mean PageRank : 1.31509732e-04
fx >> |
```

Figure 5. Ranking computation

2.4. Bolzano method implementation

The Bolzano method is often referred to as the Bisection Method which is an iteration between the interval limits, so that iteration is guaranteed to converge provided that within the interval there are differences in the intersection or sign. This method is calculated based on the eigenvalues before and after the calculation, the results are then averaged to produce the latest eigenvalues that are expected to converge.

$$\lambda = \frac{\lambda_1 + \lambda_2}{2} \text{ then } \lambda_{k+1} = \lambda_2 + |\lambda_2 - \lambda_1| \alpha \quad (4)$$

Bolzano divides the two values in the interval (λ_1, λ_2) so that the latest eigenvalue is the value in the interval (λ_1, λ_2) and with factor α . Bolzano implementation can be seen on Figure 6.

```
P = P'; % much faster if working with columns
for i=1:n
k = sum(P(:,i));
if (k ~= 0)
P(:,i) = P(:,i) / k;
end
lambda=(lambda1+lambda2)/2;
end
```

Figure 6. Modified algorithm with Bolzano method

Kamvar on Langville and Meyer [26] powered PageRank algorithm and translate with Matlab by other researcher.

2.5. Calculating linear regression

The next process is to calculate the linear regression value based on the ranking that has been sorted by the smallest value to the highest. Regression process using two variables X (first ranking score) and Y (second ranking score), where X is the origin nodes score of each student processed by the system, while Y is destination nodes the function value or called the dependent variable. This calculation gives the results of a function in (5).

$$Y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + \dots + b_nx_n \quad (5)$$

Whereas the value of b_i is scalar and the value of $x_i = \lambda$.

3. RESULTS AND DISCUSSION

After applying the method, the next step is to analyze the results of the computations that have been done. Computing is done in a short time, ranging from 1.2 seconds to 1.4 seconds. In Figure 7 it appears that column C is a list of student plagiarism scores with the student identification number shown in column B. In column D, a value of 8.7 is obtained from the subtraction between the plagiarism scores in column C, namely 2.3 and 11. This iteration is carried out until it finds one number at the end of the iteration. In this study, the last number generated from the calculation is -1448.7 which is shown in column O. The calculation results provide a function that can be used to determine the group in the next plagiarism score.

$$Y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + \dots + b_nx_n \quad (6)$$

With $b_1=8.7$; $b_2=-5.7$; ...; $b_n=-1448.7$;

These results indicate that there is a grouping of students based on gradient slope levels for each constant associated with variable X , students who have the same gradient are students with similar level of groups and need to get motivation independently in the group.

$$group - 1 = b_1/b_0 \dots \dots group-n = b_n/b_{n-1} \quad (7)$$

Students in the same group can help other students in the group to motivate one another so that the plagiarism score becomes smaller. Total group on this experiment reached with $n = 13$. The results of this calculation indicate that the use of PageRank without being combined with the Bolzano method has a difference, where Bolzano provides results with smaller time angle computing.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
	number	idstudent	plag_score												
	7	717	2.3	8.7											
	20	730	11		-5.7										
	23	733	21	3		9.7									
	5	715	24		4		-20.7								
	16	726	28	7		-11		40.7							
	17	727	35		-7		20		-72.7						
	1	711	43	0		9		-32		122.7					
	8	718	43		2		-12		50		-203.7				
	19	729	48	2		-3		18		-81		340.7			
	21	731	50		-1		6		-31		137		-570.7		
	9	719	52	1		3		-13		56		-230		923.7	
	22	732	53		2		-7		25		-93		353		-1448.7
	3	713	63	3		-4		12		-37		123		-525	
	12	722	66		-2		5		-12		30		-172		
	18	728	69	1		1		0		-7		-49			
	13	723	70		-1		5		-19		-19				
	6	716	71	0		6		-19		-26					
	11	721	71		5		-14		-45						
	10	720	72	5		-8		-64							
	2	712	77		-3		-78								
	4	714	79	2		-86									
	15	725	81		-89										
	14	724	87	-87											

Figure 7. Calculation to generate related function based on database

4. CONCLUSION

Self motivation is an important part of the curriculum where students are able to motivate themselves or others in their closest group. PageRank is a ranking algorithm used by Google to determine the importance of nodes, with combination of Bolzano that compute a root finding faster, it can help to get rank score more faster by approach in computing eigenvalue λ . The use of linear regression and the combination with finite difference in the calculation is able to provide groups in a data based on the first plagiarism score, so that in the next test of the students get different treatment based on the group that appears. The results of the study illustrate that out of 186 students, 13 groups formed with different gradients, each group had a gradient that was almost the same with a maximum error rate of 5%.

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