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Implementation of Tracer Study Data Classification at the Universitas Muhammadiyah Sumatera Utara by Utilizing Data Mining Using a Combination of Support Vector Machine and Neural Network Algorithms

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A B S T R A C T

Universities routinely conduct Tracer Studies every year with the aim of implementing accreditation data needs at the University of Muhammadiyah North Sumatra using data mining techniques. This study focuses on the use of a combination of Support Vector Machine (SVM) and Neural Network algorithms to optimize Tracer Study data classification. SVM is used to solve non-linear classification problems by finding the optimal hyperplane, while Neural Network is used to model and recognize complex patterns in the data. The research methodology includes Tracer Study data collection, data preprocessing, SVM and Neural Network model training, and evaluation of classification results. The results show that the combination of SVM and Neural Network significantly improves the accuracy and reliability of Tracer Study data classification, providing valuable insights for academic policy makers and curriculum developers at the University of Muhammadiyah North Sumatra.

INTRODUCTION

Education is the process of changing a person's way of thinking and attitude in maturing themselves through teaching and training efforts, one of which is in higher education as a level that can prepare future provisions to face the world of work, after graduating from college there will be graduates who produce quality graduates. In addition, education is a very important pillar in the formation of quality human resources where later their role can contribute and compete for the interests of national and state progress. Education is also not about teaching in class, but how to provide a good enough impact and directly influence the lives of students and alumni after they complete their studies and leave college (Wahab, 2022). The work obtained by graduates is a measure of the success of a college in education. The length of time to get a job can also be used as a benchmark for the quality of the graduates, if the graduates easily get jobs, it could indicate that they are good graduates. Every college has a system and how to get the best quality graduates such as conducting a Tracer study.

Tracer Study is a methodology used to track the academic and career success of university alumni so that universities routinely conduct Tracer studies every year which are useful for fulfilling the needs of accreditation data, improving learning and curriculum development in universities in order to improve the quality of graduates (A Kherid et al., 2021). With evidence of this graduation data, it can help universities, especially in several study programs, in evaluating the curriculum, adjusting educational programs to the demands of the job market, and improving the quality of education later by utilizing the process of extracting relevant patterns or hidden information from a dataset.

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Classification is a data analysis technique that functions to find a set of patterns, models or functions that are able to describe, differentiate and group data objects into several specific classes. There are 3 (three) stages in classification (Kwon et al., 2020). First, identify by forming a model with training data. Second, evaluate the model obtained in the first stage. The last or third, apply the model that has been evaluated using testing data. The variables in classification consist of predictor variables and response variables in the form of ordinal or nominal categorical variables. Predictor variables are factors that influence or are able to describe the response variable.

Data mining method is one of the methods used in classification. Generally, data mining is grouped into two large groups, verification and discovery. The verification method is a method that is generally a statistical technique, for example goodness of fit, analysis of variance and hypothesis testing. While the discovery method is divided into descriptive models and predictive models. Predictive models are models that predict data with results that are already known in other data. This model is obtained based on other historical data with regression and classification techniques (Križanić, 2020). Classification methods that can be used include Bayesian networks, neural networks, Support Vector Machines, decision trees, and instance based.

In the context of Tracer Study, data mining allows to analyze alumni data and find useful patterns, such as factors that influence alumni career success, industry trends of interest, or correlations between study programs and career success. And to find out the process, in the use of data mining we will use two different algorithms, namely the Support Vector Machine Algorithm and Neural Network where from the SVM side it can help classify alumni data into certain categories, for example, whether they have career success or not, based on various features such as study majors, education levels, work experience. While through the Neural Network side it is used to detect complex patterns and non-linear relationships in alumni data, helping in predicting career paths, expected salaries, or other important factors that influence success after graduation.

It is hoped that by knowing the factors that can classify the level of smoothness in getting a job, the university can provide relevant policies so that the quality of graduates will improve.

SITUATION ANALYSIS

Tracer Study

Tracer Study is information on college graduates related to the transition of college to the world of work. The study targets college graduates who are already working in an agency or entrepreneurs or graduates who are not yet working.

The results of the tracer study are also one of the requirements to be recognized by the National Accreditation Board for Higher Education (BAN-PT). Tracer research can be done in two ways, namely manually or online. According to the National Accreditation Board for Higher Education (BAN-PT), universities are established to:
1) Master, utilize, disseminate, transform, and develop science, technology, and art (Ipteks)
2) Study, explain, and preserve culture
3) Improve the quality of life of the community

Tracer Study also provides valuable information from the evaluation of education and training outcomes in certain institutions, thus tracer study is able to provide a decision to make plans for future educational activities (Noveandini, Wulandari, & Hakim, 2020).

Tracer Study plays an important role for universities in monitoring graduates, measuring the relationship between educational objectives and the processes produced with graduate status.

Tracer studies can be used to determine the relationship between higher education inputs (learning situations and conditions, student profiles, experiences, and motivations), higher education processes (learning and teaching), higher education outputs (knowledge, skills, motivation, and values), and educational outcomes (transition to work and contribution to society) (Susmanto et al., 2022).

Data Mining

Data mining includes a series of methods used to identify previously hidden patterns in collected data sets (Zai Charles, 2022). Several studies define data mining as the process of finding interesting patterns and knowledge from large amounts of data. Data sources can include databases, data warehouses, the web, other information repositories, or dynamically streamed data into the system (Mehrotra Ankit & Agarwal Reeti, 2021). Data mining is the analysis of observational data sets (often large in size) to find unexpected relationships and summarize data in new ways that are understandable and useful to data owners (Mahmud et al., 2020).

Data mining as a process used to obtain new patterns, correlations, and trends to collect large amounts of data and store them in a repository using relevant techniques or methods and pattern recognition technology (Nabila et al., 2021). The most widely used data mining technique is classification. Classification as a particular technique for categorizing or grouping data, if the data in question has a class or label. This classification can also be used to measure data changes or data forecasts over time (Adnyana I Made Budi, 2020).

Support Vector Machine

Support Vector Machine (SVM) is a supervised learning method that analyzes data and recognizes patterns. Support Vector Machine is used for regression analysis and classification with novelty detection. Usually given a set of training data in two classes, the Support Vector Machine algorithm builds a model or classification function that assigns new observations to one of the two classes on either side of a hyperplane, making it a binary linear classifier (Otchere et al., 2021). Generally, SVM management algorithms are divided into two categories, namely linear and non-linear. Linear SVM separates the data linearly, meaning the separation of two classes on a hyperplane with soft margins. Non-linear SVM, on the other hand, involves the use of kernel techniques to transform the data into a high-dimensional space (Rahman Isnain et al., 2021).

Neural Network

Artificial neural networks or Neural Networks (NN) are parallel processor systems that are connected to each other in the form of a graph. The concept of Neural Network is to adopt the ability of the human brain to provide stimulation, carry out processes and provide output (Hutomo et al., 2020). Then there is a generalization of the mathematical model of human understanding by creating a hierarchical structure by imitating brain physiology to obtain a new model for solving a problem in the real world (Hadi & Nugroho, 2020).

IMPLEMENTATION METHOD

System Design

At this stage, activities that must be carried out are arranged with the aim of being effective in preparing activity planning to produce software products that are in accordance with user needs. In the Implementation of Data Tracer Study Classification, the researcher uses a flowchart diagram to describe the application design flow in order to provide an overview of the system design process from one process to another to make it easier to understand.
In the implementation methods section, describe clearly and concisely the methods used to achieve the goals set out in the service activities. The results of the service must be measurable and the author was asked to explain the measuring instruments used, both descriptively and qualitatively. Explain how to measure the level of success of community service activities. The level of achievement can be seen in terms of changes in attitudes, socio-culture and economy of the target community.

The research stages begin with a literature review, then data sampling at the research site, then calculating the data using the neural network method, after getting the results of the calculation. The next step is to calculate the data using SVM. After calculating the two methods, they will be compared to get the prediction results which are more accurate from the two methods. Then, it will be visualized with both methods. Then in the last stage, conclusions and suggestions are obtained from the research.

Website

A website is a service that can work with an internet network. Websites can be accessed because they have a web server as a website provider. The website itself can be accessed anywhere as long as it has an internet network. A website is a collection of components consisting of text, sound, images, animations, or videos. HTML is the standard language of the website and HTTP is the document delivery path. Websites can be categorized into three categories (Rochman Abdur et al., 2020).

Hypertext Preprocessor

PHP stands for Hypertext Preprocessor, which is an open source server-side web programming language. PHP is a script that is integrated with HTML and resides on the server (server side HTML embedded scripting). PHP is a script used to create dynamic web pages. Dynamic means that the page to be displayed is created when the page is requested by the

client (Aminuddin & Arjansyah, 2022). This mechanism causes the information received by the client to always be the latest/up to date. All PHP scripts are executed on the server where the script is run.

PHP is a complementary language to HTML that allows dynamic applications to be created that allow data processing and data processing. All the syntax provided will be fully executed on the server while only the results are sent to the browser. Then it is a script language that is placed on the server and processed on the server. The results will be sent to the client, where the user uses the browser. PHP is known as a scripting language, which is integrated with HTML tags, executed on the server, and used to create dynamic web pages such as Active Server Pages (ASP) or Java Server ages (JSP). PHP is an Open Source software (Hermiati Reza et al., 2021).

RESULTS AND DISCUSSION

The results of the interface display are the stage where the system or application is ready to be operated in the actual conditions according to the results of the analysis and design carried out, so that it will be known whether the system or application built can produce a goal that is achieved, and this data mining application is equipped with a display that aims to facilitate its users. The function of this interface is to provide input and display output from the application. This application has an interface consisting of a login menu, Students, and a process menu.

Main Menu

In the Main Menu to display the menu display at the beginning of the system, namely the login menu and the main menu. The Main Menu menu is as follows.

1. Login Menu
   The login menu is used to secure the system from irresponsible users before entering the main menu. The following is the login menu display:

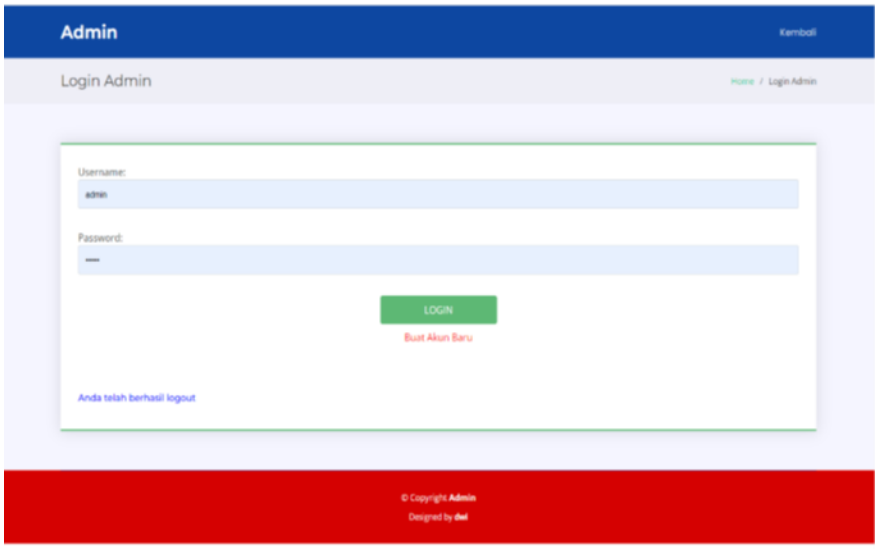


Figure 1. Login Menu

2. Main Menu
   The Main Menu is used as a link for Student data, processes and reports. Here is the main menu display:

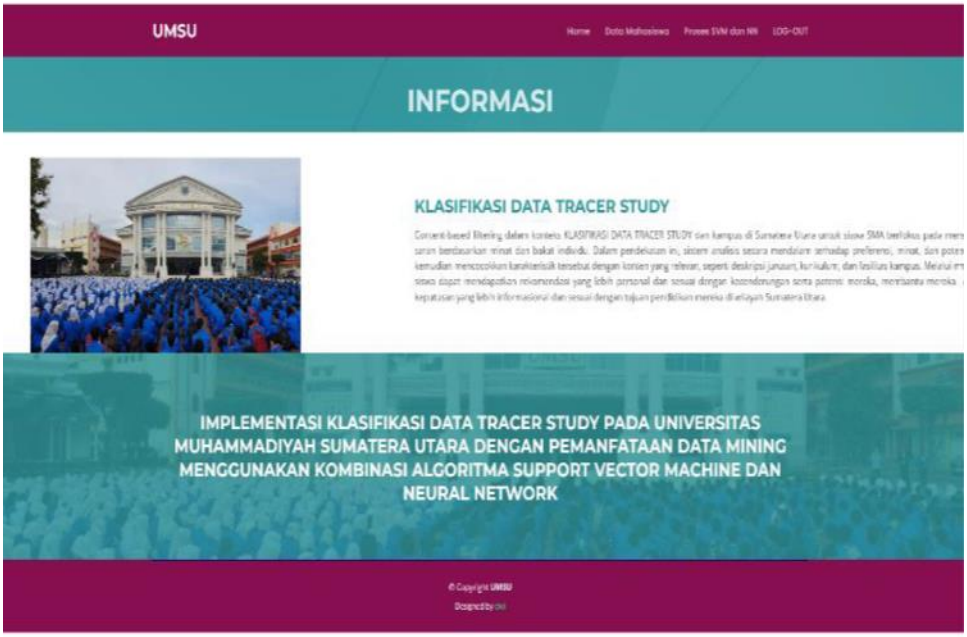


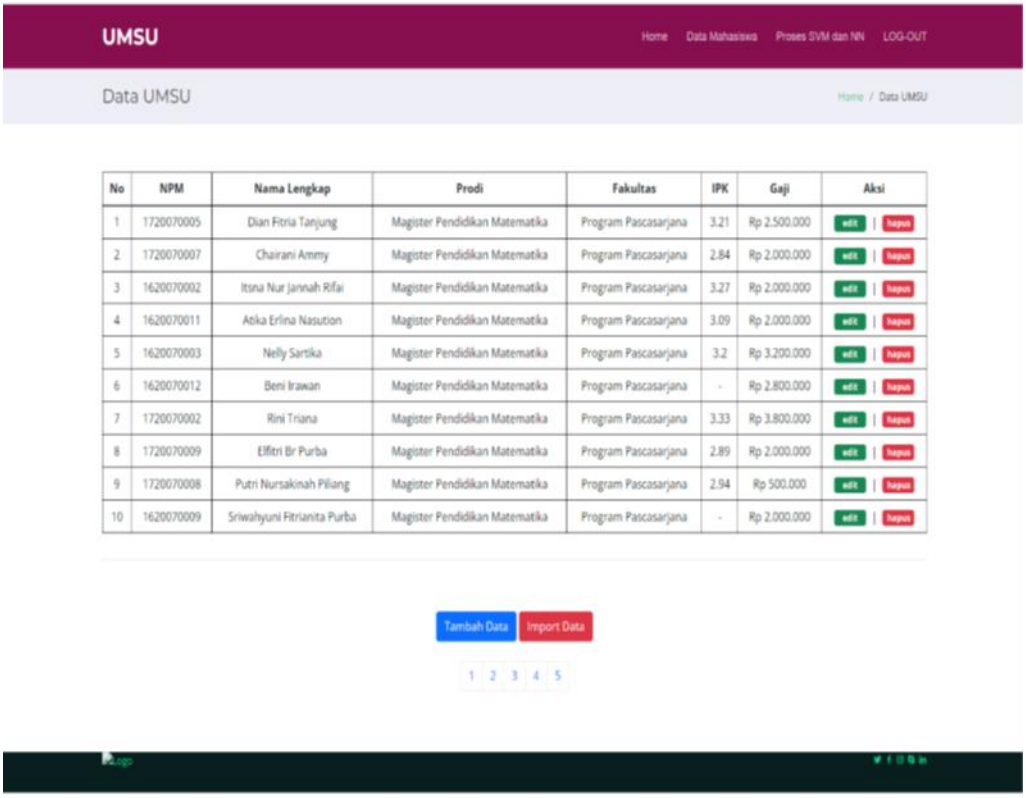
Figure 2. Main Menu

3. Adminstrator Page

In the administrator to display the data processing menu on data storage into the database, namely the Student menu and the Support Vector Machine and Neural Network process. The main administrator page menu is as follows.

a. Student Data Menu

The Student data menu for processing Student data at the University of Muhammadiya North Sumatra. The Student data menu is as follows.

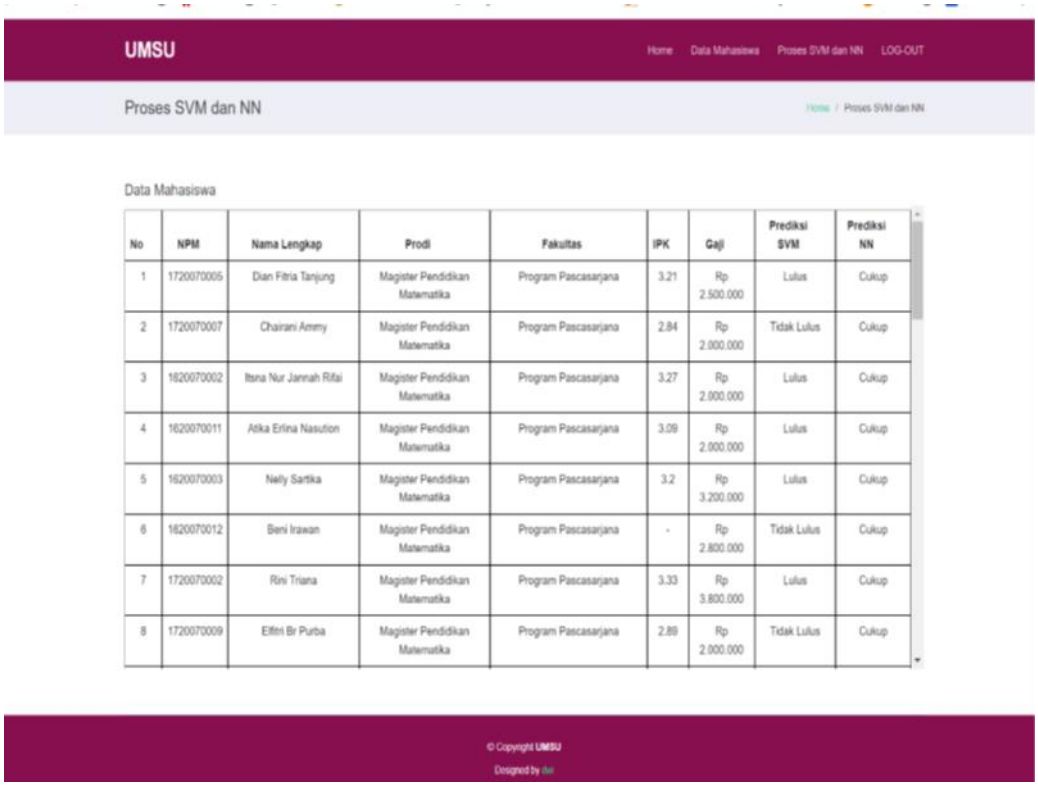


No	NPM	Nama Lengkap	Prodi	Fakultas	IPK	Gaji	Aksi
1	1720070005	Dian Fitria Tanjung	Magister Pendidikan Matematika	Program Pascasarjana	3.21	Rp 2.500.000	edit | hapus
2	1720070007	Chairani Ammy	Magister Pendidikan Matematika	Program Pascasarjana	2.84	Rp 2.000.000	edit | hapus
3	1620070002	Itsna Nur Jannah Rifai	Magister Pendidikan Matematika	Program Pascasarjana	3.27	Rp 2.000.000	edit | hapus
4	1620070011	Atika Erlina Nasution	Magister Pendidikan Matematika	Program Pascasarjana	3.09	Rp 2.000.000	edit | hapus
5	1620070003	Nelly Sartika	Magister Pendidikan Matematika	Program Pascasarjana	3.2	Rp 3.200.000	edit | hapus
6	1620070012	Beni Irawan	Magister Pendidikan Matematika	Program Pascasarjana	-	Rp 2.800.000	edit | hapus
7	1720070002	Rini Triana	Magister Pendidikan Matematika	Program Pascasarjana	3.33	Rp 3.800.000	edit | hapus
8	1720070009	Elfitri Br Purba	Magister Pendidikan Matematika	Program Pascasarjana	2.89	Rp 2.000.000	edit | hapus
9	1720070008	Putri Nursakinah Piliang	Magister Pendidikan Matematika	Program Pascasarjana	2.94	Rp 500.000	edit | hapus
10	1620070009	Sriwahyuni Fitrianita Purba	Magister Pendidikan Matematika	Program Pascasarjana	-	Rp 2.000.000	edit | hapus

Figure 3. Student Data Menu

b. Support Vector Machine and Neural Network Process Menu

The Support Vector Machine and Neural Network process menu is used to process data classification of tracer study data at the University of Muhammadiyah North Sumatra using the Decision Tree method. The Support Vector Machine and Neural Network process menu is as follows.

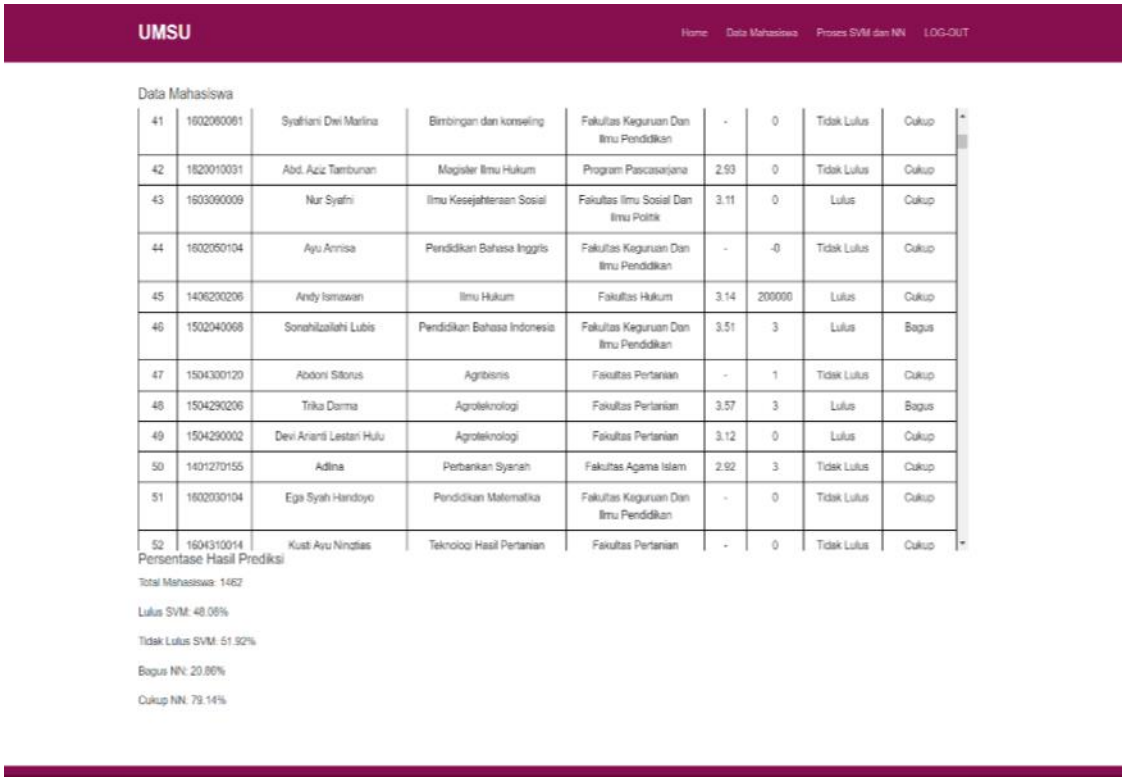


No	NPM	Nama Lengkap	Prodi	Fakultas	IPK	Gaji	Prediksi SVM	Prediksi NN
1	1720070005	Dian Fitria Tanjung	Magister Pendidikan Matematika	Program Pascasarjana	3.21	Rp 2.500.000	Lulus	Cukup
2	1720070007	Chairani Ammy	Magister Pendidikan Matematika	Program Pascasarjana	2.84	Rp 2.000.000	Tidak Lulus	Cukup
3	1620070002	Itsna Nur Jannah Rifai	Magister Pendidikan Matematika	Program Pascasarjana	3.27	Rp 2.000.000	Lulus	Cukup
4	1620070011	Atika Erlina Nasution	Magister Pendidikan Matematika	Program Pascasarjana	3.09	Rp 2.000.000	Lulus	Cukup
5	1620070003	Nelly Sartika	Magister Pendidikan Matematika	Program Pascasarjana	3.2	Rp 3.200.000	Lulus	Cukup
6	1620070012	Beni Irawan	Magister Pendidikan Matematika	Program Pascasarjana	-	Rp 2.800.000	Tidak Lulus	Cukup
7	1720070002	Rini Triana	Magister Pendidikan Matematika	Program Pascasarjana	3.33	Rp 3.800.000	Lulus	Cukup
8	1720070009	Elfini Br Purba	Magister Pendidikan Matematika	Program Pascasarjana	2.89	Rp 2.000.000	Tidak Lulus	Cukup

Figure 4. Support Vector Machine and Neural Network Process Menu

Testing

In this section you are asked to conduct testing with new data sampling and in this section you are asked to be able to test the accuracy of the system you designed with previously tested and calibrated tools. The results of the program process in the tracer study data classification are as follows.



41	1602060061	Syafriani Dwi Marlina	Bimbingan dan konseling	Fakultas Keguruan Dan Ilmu Pendidikan	-	0	Tidak Lulus	Cukup
42	1820010031	Abd. Aziz Tambunan	Magister Ilmu Hukum	Program Pascasarjana	2.93	0	Tidak Lulus	Cukup
43	1603090009	Nur Syafni	Ilmu Kesejahteraan Sosial	Fakultas Ilmu Sosial Dan Ilmu Politik	3.11	0	Lulus	Cukup
44	1602050104	Ayu Annisa	Pendidikan Bahasa Inggris	Fakultas Keguruan Dan Ilmu Pendidikan	-	-0	Tidak Lulus	Cukup
45	1406200206	Andy Ismawan	Ilmu Hukum	Fakultas Hukum	3.14	200000	Lulus	Cukup
46	1502040068	Sonahilzallahi Lubis	Pendidikan Bahasa Indonesia	Fakultas Keguruan Dan Ilmu Pendidikan	3.51	3	Lulus	Bagus
47	1504300120	Abdoni Sitorus	Agribisnis	Fakultas Pertanian	-	1	Tidak Lulus	Cukup
48	1504290206	Trika Dorma	Agroteknologi	Fakultas Pertanian	3.57	3	Lulus	Bagus
49	1504290002	Devi Arianti Lestari Hulu	Agroteknologi	Fakultas Pertanian	3.12	0	Lulus	Cukup
50	1401270155	Adlina	Perbankan Syariah	Fakultas Agama Islam	2.92	3	Tidak Lulus	Cukup
51	1602030104	Ega Syah Handoyo	Pendidikan Matematika	Fakultas Keguruan Dan Ilmu Pendidikan	-	0	Tidak Lulus	Cukup
52	1604310014	Kusti Ayu Ningtias	Teknologi Hasil Pertanian	Fakultas Pertanian	-	0	Tidak Lulus	Cukup

Figure 5. Results of Support Vector Machine and Neural Network Analysis

Implementation of SVM and NN

The student data has been validated and formatted to be fed into the SVM and NN models. This includes ensuring that any required values (such as GPA) are available and in the required format.

Table 1. Data Preprocessing

NPM	Full Name	IPK
1720070005	Dian Fitria Tanjung	3.21
1720070007	Chairani Ammy	2.84
1620070002	Itsna Nur Jannah Rifai	3.27
1620070011	Atika Erlina Nasution	3.09
1620070003	Nelly Sartika	3.2
1620070012	Beni Irawan	-
1720070002	Rini Triana	3.33
1720070009	Elfitri Br Purba	2.89
1720070008	Putri Nursakinah Piliang	2.94
1620070009	Sriwahyuni Fitrianita Purba	-
1620070014	Nur Alfiani Hafidzah	3.4
1720070003	Witya Pangestika. S	3
1720070004	Muhammad Yahfin Dasopang	3.28
1620070008	Hafiza Yusni	-
1620070001	Retno Warsih Khairani	3.04
1620070007	Agus Syafrizal	3.32
1502050013	Ariani	3.7
1502070024	Riky Prayudi	3.48
1601270003	Imawati	-
……	…..	…..
1502040119	Sri Ramadani Siregar	3.64

After training both models (SVM and NN), you can analyze the prediction results and compare their performance. Make sure to choose the model that gives the most accurate results and fits the research objectives in Figure 6. as follows.

Data Mahasiswa

41	1602080081	Syafriani Dwi Martina	Bimbingan dan konseling	Fakultas Keguruan Dan Ilmu Pendidikan	-	0	Tidak Lulus	Cukup
42	1820010031	Abd. Aziz Tambunan	Magister Ilmu Hukum	Program Pascasarjana	2.93	0	Tidak Lulus	Cukup
43	1603090009	Nur Syafni	Ilmu Kesejahteraan Sosial	Fakultas Ilmu Sosial Dan Ilmu Politik	3.11	0	Lulus	Cukup
44	1602050104	Ayu Annisa	Pendidikan Bahasa Inggris	Fakultas Keguruan Dan Ilmu Pendidikan	-	-0	Tidak Lulus	Cukup
45	1406200206	Andy Ismawan	Ilmu Hukum	Fakultas Hukum	3.14	200000	Lulus	Cukup
46	1502040068	Sonahilzailahi Lubis	Pendidikan Bahasa Indonesia	Fakultas Keguruan Dan Ilmu Pendidikan	3.51	3	Lulus	Bagus
47	1504300120	Abdoni Sitorus	Agribisnis	Fakultas Pertanian	-	1	Tidak Lulus	Cukup
48	1504290206	Trika Darma	Agroteknologi	Fakultas Pertanian	3.57	3	Lulus	Bagus
49	1504290002	Devi Arianti Lestari Hulu	Agroteknologi	Fakultas Pertanian	3.12	0	Lulus	Cukup
50	1401270155	Adlina	Perbankan Syariah	Fakultas Agama Islam	2.92	3	Tidak Lulus	Cukup
51	1602030104	Ega Syah Handoyo	Pendidikan Matematika	Fakultas Keguruan Dan Ilmu Pendidikan	-	0	Tidak Lulus	Cukup
52	1604310014	Kusti Ayu Ningtias	Teknologi Hasil Pertanian	Fakultas Pertanian	-	0	Tidak Lulus	Cukup

Persentase Hasil Prediksi

Total Mahasiswa: 1462

Lulus SVM: 48.08%

Tidak Lulus SVM: 51.92%

Bagus NN: 20.86%

Cukup NN: 79.14%

Figure 6. Results of Support Vector Machine and Neural Network Analysis

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the analysis of the implementation of Tracer Study data classification at the University of Muhammadiyah North Sumatra by utilizing data mining using a combination of Support Vector Machine (SVM) and Neural Network (NN) algorithms, the following conclusions can be drawn: Based on the results of the analysis, the use of a combination of SVM and NN algorithms can be effectively used to classify Tracer Study data at the University of Muhammadiyah North Sumatra. This is supported by a research approach using observation, interviews, and literature studies as relevant references. This study shows that the application of data classification using a combination of SVM and NN in processing alternative data and Tracer Study variables can help universities make more accurate decisions in managing their graduate data and careers. In designing the data classification application, the UML (Unified Modeling Language) modeling language is used including use case diagrams, class diagrams, and activity diagrams to build web-based applications. The implementation is carried out using the PHP programming language and MySQL database, according to the needs in managing Tracer Study data at the University of Muhammadiyah North Sumatra. The results of the system test show that the use of a combination of SVM and NN can reduce the error rate before implementing web-based data classification in classifying Tracer Study data, increasing efficiency and effectiveness in decision making related to university graduates.

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