RESEARCH ARTICLE

Application of Naive Bayes Algorithm for Physical Fitness Level Classification

Erick BURHAEİN[1]* , Akhmad FADJERİ[2]* and Ibnu Prasetyo WİDİYONO[3]*

[1,3]Universitas Maarif Nahdlatul Ulama Kebumen, Faculty of Teacher Training and Education, Department of Sports Education, Kebumen / Indonesia
[2]University Maarif Nahdlatul Ulama Kebumen, Faculty of Engineering, Department of Informatics Engineering, Kebumen / Indonesia
*Corresponding author: erick.burhaein@umnu.ac.id

Abstract
The implementation of physical fitness tests requires adequate facilities, so technology is needed to make it easier without having to provide facilities. The purpose of this study is to make it easier to get the results of a person's physical fitness level using age, gender, height and weight data through an intelligent system using the naïve Bayes algorithm without having to do a physical fitness test. This research is included in the Experimental research. The method used in this study used machine learning and classification with the naïve Bayes algorithm. Data analysis techniques use probability by using data tests and evaluations. The evaluation used uses accuracy. The population in this study was 100 college students. Training model scheme 98 and test 2 get an accuracy value when training is 100%, on testing an accuracy value of 50%. The best model is used as a reference in predicting new data, using 5 new data where 3 data already know the VO2Max value with the same prediction value and actual value, then 2 new data are not yet known VO2Max value, the 4th data gets a value of 44.2 and the 5th data gets a value of 33.2. The results of VO2Max testing using the naïve Bayes algorithm are declared accountable. Contribution to future research is to multiply research datasets to improve accuracy and improve user interface quality through development research.

Keywords
Bayes Algorithm, Intelligent System, Physical Fitness, Sport Technology, Vo2Max

INTRODUCTION

Sport is a body activity that aims to increase endurance to stay physically and spiritually fit (Prasetya, 2021; Purwanto & Burhaein, 2021; Susanto et al., 2022a). This life move causes a diminish in one component of physical wellness, to be specific cardiorespiratory wellness or what is regularly alluded to as the most extreme oxygen volume level. Wear could be a human require that's the most component and is exceptionally powerful within the arrangement of a solid soul (otherworldly) and physical (body or body). Each human who frequently does sports exercises will have way better otherworldly and physical wellbeing than people who seldom or never do sports exercises (Burhaein, Demirci, et al., 2021; Syahri et al., 2023). Perseverance is one of the vital components of physical condition and can be said to be the establishment for creating other physical conditions. The pattern of sports activities should be structured and planned to obtain good results. The physical abilities and skills of each person are different, so the basis for the implementation of sports activities must consider various things to obtain effective results. Sports

activities have three objectives (**Burhaein, Tarigan, et al., 2021; Phytanza et al., 2023**), namely: 1) education, which means sports that are carried out as part of the educational process and continue to obtain knowledge through sports activities that have been prepared through a certain curriculum. 2) Achievement, which is a sport that fosters sportsmen in a planned, tiered, and sustainable manner that aims to achieve certain achievement goals. 3) Recreation, which is a sports activity carried out by the community with hobbies and abilities in accordance with community conditions for health, fitness, and excitement. Of these various goals, sports achievements are a very promising alternative to one's life. Because in addition to getting health, you will also get promising finances.

Sports achievements became one of the goals that society dominated because. Sports achievements become a very promising alternative to one's life. Because in addition to getting health, you will also get promising finances. Sports achievement is the optimal result achieved by a sportsman in the form of ability and skill in completing tasks, both in team and individual competitions (**Jannah et al., 2021; Susanto et al., 2022b**). Many things must be done to achieve optimal achievement, including skills, intelligence, personality, and most importantly a person's physical condition. VO2 Max can also be called maximum oxygen consumption or maximum oxygen uptake or aerobic capacity (**Laishram Santosh Singh, 2022**). VO2Max can be measured in several ways, namely a 12-minute running test, a 15-minute running test, a multi-stage running test (bleep test), and a Harvard step test. Talking about sports achievements cannot be separated from the physical condition of athletes. One way to determine the need for the maximum amount of oxygen when doing physical exercise is to measure VO²Max, namely Maximum Oxygen Volume.

Artificial intelligence or artificial intelligence is a field of science from computer science (technology) that mimics human behavior (**Jamaaluddin &; Sulistyowati, 2021**). To identify a person's VO2Max Prediction without bringing in his person or testing needs an expert system or expert system to make predictions, in other words, the researcher intends to adopt the experience of someone who is accustomed to calculating VO2Max Prediction with features of gender, weight, height, age, bleep test.

The problem that occurs is the constraints of the VO2Max measurement program as a basis for measuring athletes' physical fitness as one of the foundations of sports achievement. Various student activities, both academic and non-academic, are obstacles to the VO2Max measurement process. For this reason, we tried to make a VO2Max measurement application with the Naive Bayes Algorithm system for Physical Fitness Level Classification. Athlete Physical Fitness Data can be obtained by knowing by analyzing a person's height and weight to be able to get VO2Max data as a benchmark for Athlete Physical Fitness. This will certainly make it easier for us to predict a person's physical fitness without doing certain tests.

Some studies that use expert systems for expert prediction systems built in detecting covid-19 using naïve Bayes algorithms get able to make predictions according to the truth. Research conducted to detect symptoms of diabetes using the naïve Bayes algorithm obtained an accuracy value of 100%. Research in predicting oxygen before cycling using the ANN algorithm has achieved reliable accuracy (**Diseases et al., 2018; Insani & Son, 2018; Borror et al., 2019**).

MATERIALS AND METHODS

Physical Fitness

Physical Wellness or regularly called physical wellness could be a person's capacity to carry out every day exercises without encountering noteworthy weariness, and still have vitality saves to do other startling things (**Catur & Mujiriah, 2021; Winata & Mujirah, 2021**). Physical fitness in everyday life is the ability of a person to do certain body activities, without experiencing fatigue or fatigue that is significant after carrying out an activity, so that there is still residual energy to carry out other activities. In addition, the exercises carried out need to involve components in physical fitness related to health, namely: flexibility, power, endurance, VO2 max, and body composition.

VO²Max

VO2 Max can also be called maximal oxygen consumption or maximal oxygen uptake or aerobic capacity (**Laishram Santosh Singh, 2022**). VO2Max can be measured in several ways, namely the 12-minute running test, the 15-minute running test, the multi-stage running test (bleep

test), and the Harvard bench test (Harvard step test). Talking about sports achievements cannot be separated from the physical condition of athletes. One way to determine the need for the maximum amount of oxygen when doing physical exercise is to measure VO²Max, namely Maximum Oxygen Volume. VO2 max is a form of evaluation of a person's physical condition. VO²Max describes the level of effectiveness of the body to get oxygen, then channeling it to muscles and other cells using use it in the form of energy, where at the same time the body removes metabolic waste that can inhibit physical activity. Someone who has a high VO²Max will tend to be able to do more activity than people who have a lower VO²Max so the greater a person's VO²Max, the better they are in accepting and dealing with physical work. Someone who has good endurance and stamina has a high VO2 max value.

Performance Coaching

Sports coaching and sports achievement development are carried out and directed to achieve sports achievements at the regional, national, and international levels carried out by the parent sports organization at the central and regional levels. Sports achievements can be achieved by requiring good management or management, effectiveness in carrying out activities is a demand for every organization to achieve goal. The implementation of the development of organizational achievements is one way to be able to carry out systematic and structured development. One institution that plays a lot of role in the contribution of athletes is Higher Education, at that age, it is a golden age in the formation of sports achievement, so the Student Activity Unit (UKM) in the field of sports must continue to be encouraged to support student contributions in improving sports in the region through sports achievements. Higher education has a focus on student activity units in the field of sports The student activity units in the field of sports include: Football UKM, Futsal UKM, Handball UKM, Pentaque UKM, Badminton UKM, Volleyball UKM, Rugby UKM, etc. Coaching in university sports organization units should need to be maintained, including organizational structure, financing, and training programs. The training program itself was created to measure the progress of athletes' skills and physical condition in college. With good physical condition, it is expected that the athlete's

performance will be well maintained as well. A good physical condition is in line with a person's VO2Max, the better a person's VO2Max ideally has a good physical condition.

Artificial Intelligence

Artificial intelligence or artificial intelligence is a field of science from computer science (technology) that imitates human behavior (Jamaaluddin & Sulistyowati, 2021). Human indicators, rules, calculations and decisions are closely related to the definition of an expert system (Goldberg, 1989). Expert system is a branch of artificial intelligence (Goldberg, 1989). AI can make decisions quickly in all aspects (Li, 2023) with human-like rules and calculations. AI can serve in the fields of pharmaceutical, economic, technological, agricultural, social, and military (Jamaaluddin & Sulistyowati, 2021).

The field of phapharmacy/ health self is used for hospital logistics decisions and deciddecisionsractical work (Jamaaluddin & Sulistyowati, 2021). In economics, it is used to decide in taking financial credit. In social life, AI caadaptpt how familiarity generates trust (Cristina et al., 2023; Horowitz et al., 2023). As well as human attachments, rules, calculations, and decisions. Rules and calculations are definitions of algorithms (Goldberg, 1989; Donald E. Knuth, 1977). AI and ES must have algorithms in finding a decision (Donald E. Knuth, 1977).

Algoritma Naïve Bayes

Algortima was first proposed by Al-Khawarizmi who was a mathematician, astronomer and geographer in the 9th century AD (Influence et al., 2023). Algorithms are mathematical procedures or rules created to provide alternative solutions (Knuth, 1977). An algorithm is a compound control structure that is limited, abstract, effective, imperatively given, achieving certain goals under given conditions (Hill, 2015). Algorithms must have input criteria, outputs, have clear directions and have limitations with their role methods with fundamental algorithms, flow charts, pseudo code (Knuth, 1977).

The Naïve Bayes Classifier is a classification method rooted in Bayes' theorem. The main feature of this Naïve Bayes Classifier is the exceptionally solid presumption of freedom from each condition (Wibawa et al., 2018). In Bayes' theorem, if there are two separate events

(e.g. A and B), then Bayes' theorem is formulated as follows:

$$P(A|B) = \frac{P(A)}{P(B)} P(B|A)$$

Bayes' theorem is often developed in view of the enactment of the law of total probability, as follows:

$$P(A|B) = \frac{P(A)P(B|A)}{\sum_{1=1}^{n} P(A|B)}$$
$$dimana \ A_1 \ U \ A_2 \ U \dots Un = S$$

To explain the Naïve Bayes theorem, it is important to note that the classification process requires a number of clues to determine what class is suitable for the analyzed sample. Therefore, the above Bayes theorem is adjusted as follow:

$$P(C|F_1 \dots F_n) = \frac{P(C)P(F_1 \dots F_n|C)}{P(F_1 \dots F_n)}$$
.

Where variable C speaks to lesson, whereas variable F1... Fn speaks to the characteristic characteristics of the clues required to perform the classification. So the equation clarifies that the chance of section of tests with certain characteristics in lesson C (back) is the chance of course C showing up (**Wibawa et al., 2018**).

Evaluasi Algoritma

Evaluation of the algorithm is needed to determine the performance of the algorithm (**Fadjeri et al., 2020**). However, in this study it was used to find out the prediction results from training data and testing data. The evaluation in this study uses *accuracy* (Armstrong, n.d.).
The *accuracy* formula is as follows

$$Accuracy = \frac{a+d}{a+b+c+d}$$
(Santra & Christy, 2012)

Accuracy or accuracy is widely used in algorithm evaluation.

METHODS

The method used in this study uses two parts, namely the machine learning method and the classification method with the naïve Bayes algorithm (**Borror et al., 2019**). Naive Bayes algorithms are used in machine learning and classification because naïve Bayes algorithms get the best accuracy from research (**Woollam et al., 2020; Diseases et al., 2018; Insani & Putra, 2018**). Machine learning is a method of receiving and analyzing input data to then be able to predict the output value of the research dataset (**Zignoli et al., 2020**).

Participants

Research participants are subjects who voluntarily give consent to participate in a scientific study. Participants became a source of data that researchers used to gather research information from a variety of backgrounds, including various age groups and genders. Before participating in a study, participants are usually provided with complete information about their research objectives, procedures, risks, benefits, and rights. Participants gave voluntary consent after understanding the information from the researcher. The population in this study was students who participated in the Student Activity Unit in the field of sports. The sample in this study was students who participated in Football, Futsal and Volleyball sports totaling 100 students.

Based on the letter of determination of ethical clearance regarding the determination of the validity of fitness research data of participants of the Student Activity Unit in the field of sports, it is declared valid for research. The research subject has given in-depth, informational, and voluntary consent before engaging in the research. Researchers are responsible for ensuring that research subjects fully understand the objectives, methods, risks, and benefits of research carried out in accordance with the Helsinki Statement. Additional precautions were taken by the investigator(s) to protect the volunteers in this study.

Data Collection Tools

Data collection for this study is age, sex, weight and height data involving a series of steps to obtain accurate and representative information. Participants fill in biodata by showing an identity card (KTP) or other identity to find out gender and age. Height measurement with a calibrated stadiometer, while for weight measurement with a calibrated scale.

The data collection tool in this study was using the Beep Test. A method of measuring physical fitness that involves running back and forth between two points on a track according to a certain tempo. As time goes by, the tempo will increase, and participants should try to keep running according to the specified tempo. When participants can no longer keep up with the tempo or reach the line at the allotted time, the test is

stopped, and fitness levels are measured based on the last stage successfully achieved.
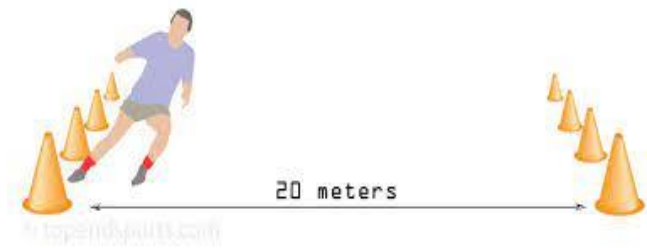

Figure 1. Implementation of beep test
Source: (Wood, 2023)

Design Test

Test design refers to the process or data collection techniques including height data, weight data, and physical fitness data using the Beep Test.

1. Participants fill out a statement of willingness.
2. Participants fill in their age and gender biodata by showing an identity card (KTP) or other personal identification that indicates student status.
3. Participants measure height with a calibrated stadiometer.
4. Participants measure their weight with a calibrated scale.
5. Participants are given an understanding of the technical implementation of physical fitness tests with beep tests.
6. Prepare test takers to be tested.
7. Prepare the tools needed, namely, multi-stage fitness audio, cones, whistles, stationery, paper, and a stopwatch.
8. The officer records the results of the achievement of the physical fitness test.

Training Intervention

The treatment was carried out several times until it got the highest accuracy score in machine learning using native bayes algorithms. The 100 data will be divided into training data and testing data. With the best scheme at least 90% data training and 10% data testing and several treatment schemes to get the highest accuracy value

Classification is done with new data with methods that have been obtained in the best machine learning mode. Data analysis techniques use probability (naïve Bayes) using data testing and evaluation. The evaluation used uses accuracy, and then the explanation is seen in Figure 1.
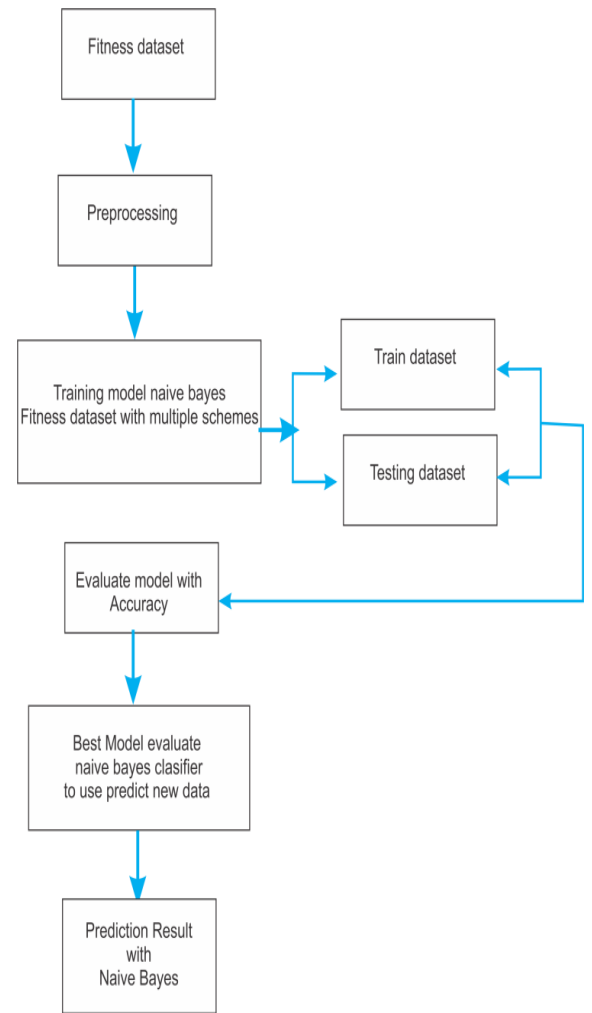
.

Figure 1. Research flow

In table 1 there are 100 data with features gender, height, weight, bleep test result, age, and VO2Max prediction. The 100 data will be a reference in machine learning in artificial intelligence with the Naive Bayes algorithm. Once machine learning is done, VO2Max prediction testing with new data that is not from the 100 sections can be done.

Statistical Analysis

Evaluation of the algorithm is needed to determine the performance of the algorithm (**Fadjeri et al., 2020**). However, in this study it was used to find out the prediction results from training data and testing data. The evaluation in this study uses *accuracy* (Armstrong, n.d.).

The *accuracy* formula is as follows

$$Accuracy = \frac{a+d}{a+b+c+d}$$

(Santra & Christy, 2012)

Accuracy or accuracy is widely used in algorithm evaluation

Table 1. The research dataset

| No	Gender	Height	Weight	Bleep Test Result	Age	VO$_2$Max Predictions
1	Man	162	57	11.2	20	50.8
2	Man	160	64	11.7	21	52.2
3	Woman	159	50	7.5	17	38.2
4	Man	175	61	9.3	20	44.2
5	Man	170	78	6.1	19	33.2
*	*	*	*	*	*	*
*	*	*	*	*	*	*
*	*	*	*	*	*	*
99	Woman	170	59	4.7	14	28.7
100	Woman	170	59	4.5	15	27.6

Source: Primary Data

RESULTS

With the division for machine learning obtained results, 90 data training, and 10 data testing got 25% accuracy results and averrage 62,5%. Data 99 data train 1 data test gets error accuracy results, data 95 data train 5 data testing gets 40% accuracy results and averrage 70% . Data 98 data train 2 data testing gets 50% accuracy results and averrage 75 %. With these results, for testing new data using 98 training division data and testing data 2.

Table 2 describes the machine defense scheme with 100 data in table 1. From this scheme, researchers used a scheme of 98 data training and 2 data testing with an average accuracy result of 75%. The results of such machine learning are used for prediction of new data using naïve bayes algorithms.

Table 2. Results by model/ schematic

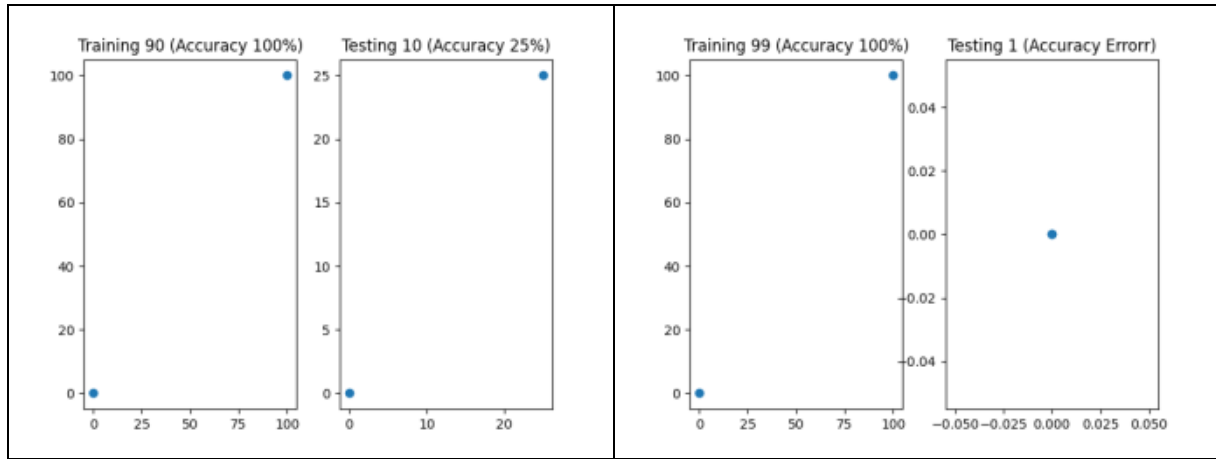| Data	Categori	Model/Schematic		
		Training	Testing	Accuracy
Data (100)	Training	90	10	100%
	Testing	90	10	25%
	Training	95	5	100%
	Testing	95	5	40 %
	Training	98	2	100%
	Testing	98	2	50 %
	Training	99	1	100%
	Testing	99	1	Error
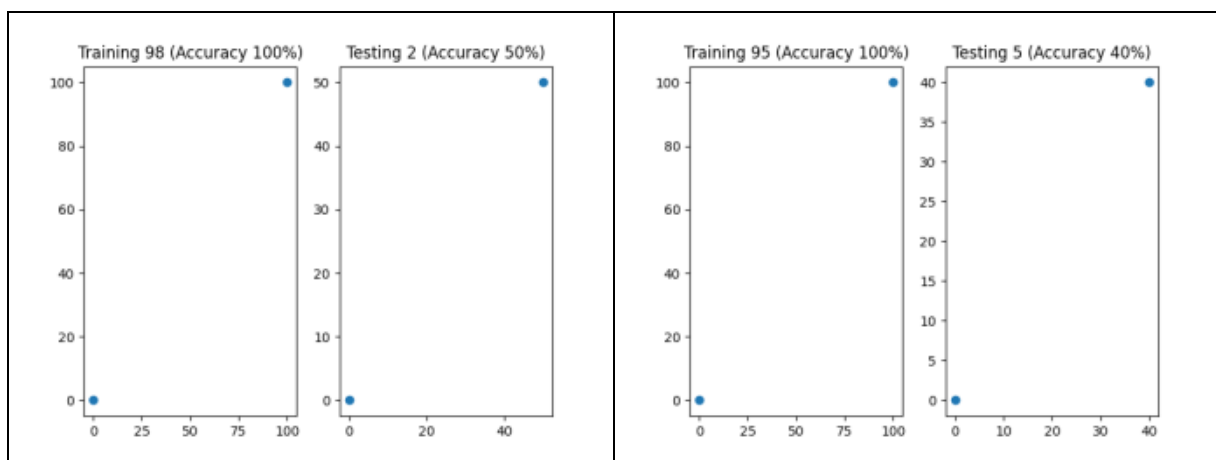
Figure 2. Testing with machine learning models using the naïve Bayes classifier algorithm
Source: Primary Data

Testing: with a machine learning model using the naïve Bayes classifier algorithm Researchers prepared 5 test datasets (new data) that were not included in the training data with 3 data already known VO2max Prediction values and 2 data unknown VO2Max PREDICTION values.

Table 3. Results reviewed actual values

No	Gender	Height	Weight	Bleep Test Result	Age	VO$_2$Max Predictions	Actual
1	Man	162	57	11.2	20	50.8	50.8
2	Man	160	64	11.7	21	52.2	52.2
3	Woman	159	50	7.5	17	38.2	38.2
4	Man	175	61	9.3	20	44,2	New data
5	Man	170	78	6.1	19	33,2	New data

Source: Primary Data

By looking at the table, it can be stated that of the 3 data that display the actual value is already known and is not part of the data from the initial 100 data, getting the appropriate value between the prediction and the actual. The VO2Max 2 prediski value of the new data gets values of 44.2 and 33.2.

Compared to previous research (**Ilham Insani et al., 2018**), This study used several machine learning schemes to get the best schema model by getting an overall accuracy value of 100% training with several models. Compared (**Zignoli et al., 2020**) which uses the ANN algorithm, this research has a more complete data set feature and the prediction evaluation results are better with an average training evaluation of 100%.

DISCUSSION

Sports are physical activities or games that are carried out with the aim of improving physical skills, health, fitness, and/or achieving competitive achievements. Sports can be divided into categories based on the main purpose or focus of the activity. The two main categories are "health sports" and "achievement sports. Fitness is a type of sport that is oriented to improve physical and general health, without focusing on a high level of competition (**Burhaein, 2022**). The main goal of health sports involves the maintenance and improvement of one's physical condition and general health. Achievement sports include sports that are played at a high competitive level. Athletes in achievement sports often train intensively and participate in competitions to achieve the highest achievements. The type of sport that is widely practiced by the community is achievement sports.

Achievement sports can involve a single individual or a team, and often have certain rules or guidelines. "Sports achievement" refers to sports activities that are performed with a focus on achieving the highest level of performance or outstanding achievement. Achievement sports often involve athletes training and competing at highly competitive levels, whether on a regional, national, or even international scale. TLET in sports of achievement focuses on developing and refining their technical, physical, and tactical skills with a high level of rigor (Singh, 2022). Intensive and structured training is an integral part of an athlete's preparation of achievement. It includes physical exercises, technical exercises, and game strategies. Athletes in achievement sports need to maintain optimal physical and mental fitness. It involves a careful exercise plan, good recovery, and a strong mental strategy.

Physical fitness plays a key role in an athlete's achievements. Physical fitness involves an optimal level of health and performance of the body, and contributes to the achievement of achievements both in sports and in everyday life (Catur & Mujiriah, 2021; Winata & Mujirah, 2021). With good physical fitness, it is expected to be able to contribute to the achievement of one's sports achievements. Therefore, to find out the level of physical fitness of athletes should be measured periodically. Physical fitness measurement has difficulties in its implementation because it requires time, energy, and adequate facilities. For this reason, it is necessary to make new breakthroughs related to measuring one's physical fitness more easily and accurately. Intelligent systems with machine learning and classification with naïve Bayes algorithms are a measure of a person's physical fitness without having to carry out physical fitness tests, only by entering age, gender, weight and height data.

The Naive Bayes algorithm is one of the classification methods used in machine learning. Although commonly used for text classification, Naive Bayes can also be applied in the context of physical fitness. This study provides findings that the results of this study are an application system that can detect a person's physical fitness just by entering age, gender, weight and height data without conducting a physical fitness test.

The importance of Naive Bayes algorithms in physical fitness depends on a number of factors, including the type of problem at hand, the nature of the available data, and the purpose of the analysis. Naive Bayes have very strong assumptions about feature independence, which may not always correspond to real-world circumstances. Therefore, the use of Naive Bayes should be carefully considered depending on the characteristics of the data and the purpose of the analysis. If your physical fitness dataset has complex dependencies between its features, perhaps other models such as logistic regression or decision trees can provide better results. The results of the study provide findings andconclusions are that the Application of Naive Bayes Algorithm for Physical Fitness Level Classification can be used to predict VO2Max with 100% accuracy. Training model scheme 98 and test 2 get an accuracy value when training is 100%, on testing an accuracy value of 50%.

This is in accordance with the theoretical concept with thetreatment naïve bayes carried out several times until obtaining the highest accuracy score in machine learning using native bayes algorithms. 100 data will be divided into training data and testing data. With the best scheme at least 90% data training and 10% data testing and several treatment schemes to get the highest accuracy value (Jamaaluddin & Sulistyowati, 2021).

Refer to the main Foundation of The field of phapharmacy/ health self is used for hospital logistics decisions and decide decision practical work (Jamaaluddin & Sulistyowati, 2021), then the results of this study concluded that the Smart system-based measuring instrument using the Naife Bayes algorithm can be used as a measuring instrument to determine one's physical fitness accurately. Next is related to the limitations and advantages of naïve bayes. The limitations of the research are on intelligent system applications that are still desktop and data input still using exel microsof. For further research, it is expected to use a more practical and flexible application based on Android. Naive Bayes algorithms tend to be simple and fast in training and prediction. This makes it suitable for problems that require efficient solutions and can be implemented quickly

Conclusions

The conclusion is that the Application of Naive Bayes Algorithm for Physical Fitness Level Classification can be used to predict VO2Max with 100% accuracy. Training model scheme 98 and test 2 get an accuracy value when training is 100%, on testing an accuracy value of 50%. The

best model is used as a reference in predicting new data, using 5 new data where 3 data already know the VO2Max value with the same prediction value and actual value, then 2 new data are not yet known VO2Max value, the 4th data gets a value of 44.2 and the 5th data gets a value of 33.2. The results of VO2Max testing using the naïve Bayes algorithm are declared accountable. The limitation of this study is that the research dataset was only for 100 participants which had an impact on the testing accuracy rate of 50% and the system was still in desktop form. Contribution to future research is to multiply research datasets to improve accuracy and improve user interface quality through development research.

Conflict of Interest

We declare that this article we wrote is not involved in any particular conflict of interest.

Ethics Statement

This study was performed by adhering to the Helsinki Declaration. Ethical approval of the study was obtained from Universitas ma'Nahdkatual Ulama Kebumen Ethics Committee at the board meeting dated 20.03.2023 and numbered 17-06-2023 Ref. 0617079003, 2023.

Author Contributions

Study Design, EB; Data Collection, EB, AF and IPW; Statistical Analysis, EB, AF and IPW; Data Interpretation, EB, AF and IPW; Manuscript Preparation, EB, AF and IPW; Literature Search, EB, AF and IPW. All authors have read and agreed to the published version of the manuscript.

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