International Journal of
Disabilities Sports and Health Sciences
e-ISSN: 2645-9094

RESEARCH ARTICLE

The Level of Accuracy of the Expert System Training Data Uses the Naive Bayes Algorithm to Measure the Distance of A Ball Kick

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Abstract
The importance of data accuracy in the implementation of long-distance kicking tests as basic data for coaches requires adequate facilities and requires large costs, so technology is needed for facility and budget efficiency. The purpose of this research is to determine the accuracy of expert system training data using the Naive Bayes algorithm to measure the distance of a ball kick. The research design used is a quantitative method with an experimental model. The type of experimental design is pre-experimental design. Participants amounted to 100 male soccer players with saturated sample technique. The instruments were question forms to obtain information on gender and age, while to measure leg muscle strength and leg muscle strength using a tape roll meter and leg dynamometer. Data validity uses calibrated tools. The data analysis technique uses probability (naive bayes) using data testing and evaluation. The results of the study obtained the accuracy level of the expert system training data using the naïve bayes algorithm with the best accuracy of 100%. There is a training data learning model used using the 99 scheme and test 1 and 98 and test 2. The conclusion is that the accuracy level of expert system training data using the naive bayes algorithm is declared to be accountable for use in classifying new data. The contribution for further research is testing using new data to determine the level of accuracy further to improve accuracy in learning training data.

Keywords
Expert System, Naive Bayes, Accuracy of Training Data

INTRODUCTION

The ability to kick long distances of soccer players in soccer matches is an integral part of the match. According to the results of data analysis of one of the soccer leagues in Europe, namely the premier league, it states that in each match an average long pass or long kick occurs an average of 60 times per team, of course this will also determine the sustainability of the playing strategy in the match (Millah et al., 2022). The importance of long-distance kicks for soccer players is the urgency of a team in determining match tactics and strategies, for this reason it is important to develop the ability to kick long distances for players (Nggola et al., 2018). Long distance kick measurements can be taken periodically to measure the development of player abilities. This is certainly an obstacle in itself to control the results of training on the long-distance kicking ability of players (Tohari et al., 2022). The ability to kick long distances is largely determined

Received: 02 July 2024 ; **Revised** ; 01 Auğust 2024 ; **Accepted:** 07 September 2024; **Published:** 25 September 2024

How to cite this article: Irawan, Y.F., Lumintuarso, R., Tirtawirya, D., Fadjeri, A., Widiyono, I.P., Melati, P., and Lourenco, C.C.V. (2024). The Level of Accuracy of the Expert System Training Data Uses the Naive Bayes Algorithm to Measure the Distance of A Ball Kick. *Int J Disabil Sports Health Sci*;7(5):1172-1179.https://doi.org/10.33438/ijdshs.1509227

by leg length, muscle strength, age, gender and sex (Baker et al., 2022).

Indonesia Muda Football Academy is one of the outstanding football academies in the city of Kebumen, Central Java, Indonesia. This football academy focuses on coaching football in all age groups and has good management. Preliminary studies have been conducted by researchers at Indonesia Muda Footbal Academy. A number of studies have often been conducted at this club. Research that is often done is limited to measuring leg muscle strength and the length of kicks in soccer training. Objective measurements in sports, especially soccer, are increasingly in demand to improve player performance and match analysis. One of the important aspects in soccer is kicking power. Expert systems with the Naïve Bayes algorithm offer the potential to provide accurate and fast measurements of soccer kicking distance. However, there is limited research that specifically addresses the accuracy of Naïve Bayes-based expert systems in measuring the distance of soccer kicks. Variations in the training data used, selection of relevant features, and algorithm parameter settings can significantly affect system performance.

Long distance kicks need to be taken to assess player performance and player quality. The measurement of long distance kicks requires a soccer field for the test. One important aspect of soccer performance analysis is the player's ability to kick the ball, especially in providing long-distance passes (Latuheru et al., 2022). The analysis of ball kicking distance is key in evaluating player performance, developing game strategies, and improving match results, but doing the analysis manually is often time consuming and not always accurate, therefore a technology is needed to facilitate the data retrieval process, one of which is AI (Artificial Intelligence) technology.

The machine learning process requires an algorithm, the algorithm to be used is the naïve bayes algorithm. Naïve Bayes algorithm is a probabilistic classification algorithm that is simple and easy to understand. It is based on Bayes' Theorem and the assumption of feature independence. Bayes' theorem is a formula used to update the probability of an event based on new information. The feature independence assumption states that all features in the training data are independent of each other. By using Bayes' Theorem and the assumption of feature independence, the Naïve Bayes algorithm can calculate the probability of a data point belonging to a particular class.

The importance of machine learning in training data in expert systems using the naïve bayes algorithm as a reference in the classification of new data. The indicator of machine learning intelligence in the expert system can be seen in the accuracy in the learning process in detecting the distance of the ball kick in a soccer game. For this reason, in order to facilitate measurement without carrying out tests, it is necessary to have an application system that is made to facilitate and predict the long distance kicking ability of players, but the training data is only limited to leg length, age, gender and leg muscle strength. This study aims to measure the accuracy of expert system training data using the Naïve Bayes algorithm to measure the distance of a ball kick. The researcher limits this research problem only to create an application system that is made to predict the ability of long distance kicks and measure the accuracy level of expert system training data using the Naïve Bayes algorithm. In the end, can expert system technology using the Naïve Bayes algorithm be used to measure the accuracy of training data?

MATERIALS AND METHODS

Expert System

Expert system is a system that adopts human expertise and intelligence into computers (Bonicalzi et al., 2023). Expert systems can be used to find out facts from an assumption (Mark S. Fox, 1990) the rules or procedures used are information obtained from human experts, and represent the information in the form of rules, such as IF-THEN. The rules can then be used to perform operations on the data to perform inference to reach the right conclusion (Liao, 2005). Expert systems can be used for verification and validation of a survey (O'Keefe & O'Leary, 1993). Like the problems found by researchers.

Naive Bayes Algorithm

Algortima was first put forward by Al-Khwarizmi who was a mathematician, astronomer and geographer in the 9th century AD (Fadjeri et al., 2021). Algorithms are mathematical procedures or rules made to provide alternative solutions (Fadjeri et al., 2020). Algorithms are compound control structures that are limited, abstract, effective, imperatively given, achieving certain goals under given conditions (Charntaweekhun &

Wangsiripitak, 2006). Algorithms must have input, output criteria, have a clear direction and have limitations with design methods with fundamental algorithms, flow charts, pseudo code (Burhaein et al., 2023). Naïve Bayes Classifier is a classification method rooted in Bayes' theorem. The main feature of the Naïve Bayes Classifier is the very strong assumption (naïve) of the independence of each condition or event (Silahudin et al., 2020). In Bayes' theorem, if there are two separate events (let's say A and B), then Bayes' theorem is formulated as follows:

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

(Fadjeri et al., 2020)

Bayes' theorem is often extended given the applicability of the law of total probability, to the following:

$$P(A|B) = \frac{P(A)P(B|A)}{\sum_{i=1}^{n} P(A|B)}$$

$$dimana\ A_1 U\ A_2 U \ldots Un = S$$

(Fadjeri et al., 2020)

To explain the Naïve Bayes theorem, it is necessary to know that the classification process requires a number of clues to determine what class the analyzed sample fits into. Therefore, the Bayes theorem above is adjusted as follows:

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

(Fadjeri et al., 2020)

Where the variable C represents the class, while the variables F1 ... Fn represent the characteristics of the characteristics of the clues needed to classify. Then the formula explains that the probability of a sample with certain characteristics being included in class C (posterior) is the probability of class C appearing.

Algorithm Evaluation

Algorithm evaluation is needed to determine the performance of the algorithm (Debelee et al., 2019), but in this study it is used to determine that the prediction results from training data and testing data. The evaluation in this study uses accuracy (Sunardi et al., 2017). The accuracy formula is as follows:

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

(Fadjeri et al., 2020)

Accuracy is widely used in algorithm evaluation.

The method used in this research uses an experimental method. Testing the accuracy results there are two parts, namely the machine learning method and the classification method with the naive bayes algorithm (Woollam et al., 2020). The naive bayes algorithm is used in machine learning and classification because the Naive bayes algorithm gets the best accuracy from research (Diseases et al., 2018; Wibawa, Muhammad, Muhammad, 2018). Machine learning is a method by receiving and analyzing input data to then be able to predict the output value of the research dataset (Borror et al., 2019). Classification is done with new data with methods that have been obtained in the best machine learning mode. The data analysis technique uses probability (naive bayes) by using data testing and evaluation.

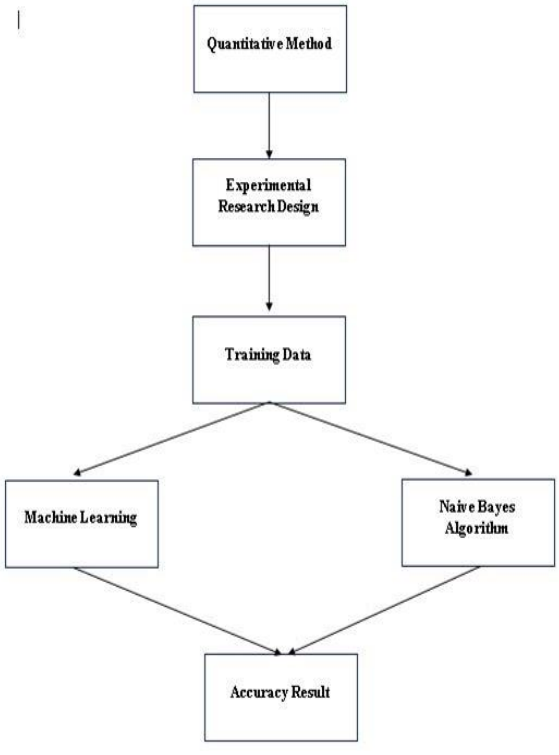

Figure 1. Research design flowchart

Participants

Research participants are subjects who voluntarily give consent to participate in scientific research. Participants are the source of data used by researchers to collect research information from a variety of backgrounds, including different age groups and genders. Before participating in a study, participants are usually given full information about the purpose of the study, procedures, risks, benefits, and their rights. Participants give voluntary consent after understanding the information from the researcher. The population in this study were soccer

players from the Indonesia Muda soccer school, totaling 100 football players.

Based on the ethical clearance letter regarding the determination of the validity of the research data from the Sekolah Sepak Indonesia Muda Kebumen club, it was declared valid for research. The research subjects have provided in-depth, informative, and voluntary consent before being involved in the research. Researchers are responsible for ensuring that research subjects fully understand the purpose, methods, risks, and benefits of the research conducted in accordance with the Helsinki Statement. Additional precautions were taken by the researcher to protect the volunteers in this study.

Data Collection Instruments

Data collection for this study is data on leg length, age, gender, leg muscle strength, and ball kick length tests which involve a series of steps to obtain accurate and representative information through appropriate validity and reliability stages. Validity of measuring instruments is an important aspect in research to ensure accurate and reliable measurement results (Saputra, 2022). All measuring instruments used in this study, namely the tape roll meter and leg dynamometer, are well calibrated. Instrument reliability refers to the extent to which the measurement instruments used in research are consistent and stable in producing measurement results. In this study, the reliability of measuring instruments is important to ensure that the measurement of ball kicking distance and other related variables is accurate and reliable. One of the steps is to test the leg dynamometer instrument used to measure leg muscle strength and the meter for measuring leg length with the same subject to assess the consistency of the measurement results and measure the variables at different times with the same subject, and calculate the correlation between the first and second measurement results to assess temporal consistency.

Participants filled in their biodata by showing their identity card (KTP) or other identity to determine gender and age. Anthropometric measurements to measure leg length using a calibrated tape measure (roll meter), leg muscle strength measured using a leg dynamometer while measuring the length of the kick using a calibrated tape measure (roll meter). Before doing the long kick test, all subjects were briefed first, after which the players warmed up sufficiently. All players were given the opportunity to do 3 long kicks and 1 kick was taken the longest.

Test Design

The test design refers to the process or technique of collecting data which includes leg length data, age data, gender data, leg muscle strength data, and data on the distance of kicking the ball.

Participants fill in age and gender biodata by showing an Identity Card (KTP) or other identification,

Participants measure limb length using a calibrated roll meter tape,

Participants measure leg muscle strength using a calibrated leg dynamometer,

Participants are given an understanding of the technical implementation of the long kick test,

Prepare the tools needed, namely, leg dynamometer, and roll meter.

Exercise Intervention

The treatment is done several times until getting the highest accuracy value in machine learning using the native bayes algorithm. The 100 data will be divided into training data and testing data. With several treatments to get the best accuracy in the machine leaning scheme. Classification is done with new data with those 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, then the explanation is seen in Figure 2.

Statistical Analysis

The stochastic calculation used uses a confusion matrix consisting of accuracy, precision, recall and F1-score. The analysis results used in the study use accuracy as the accuracy formula that has been raised and becomes a reference. Algorithm evaluation is needed to determine algorithm performance (Fadjeri et al., 2020). However, in this study it is used to determine the prediction results of training data and testing data. The evaluation in this study uses accuracy (Armstrong, n.d.).

The accuracy formula is as follows:

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

(Santra & Christy, 2012).

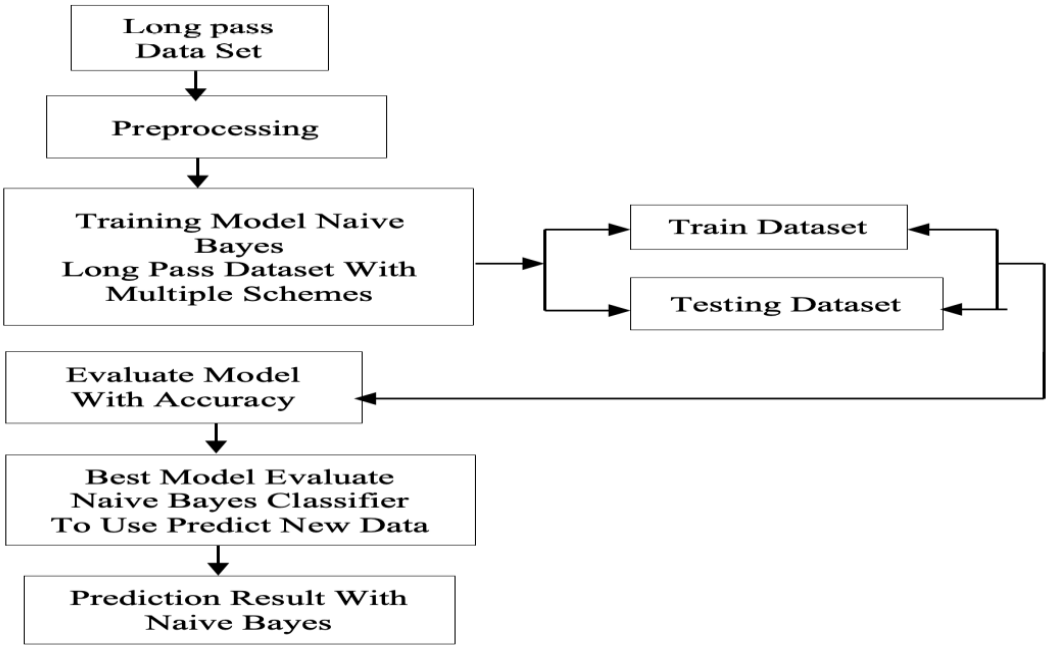

Figure 2. Research flow

RESULTS

The machine learning process uses 100 data as training data that has been validated and has ethical clearance. The training data is the data that will be carried out machine learning in the expert system using the naïve bayes algorithm.

Table 1. Train data of football players

No.	Leg Length	Leg Power	Age	Long Pass (m)	Gender	Height (cm)	Education
1	92	850	24	55	Male	165	Student
2	88	720	19	48	Male	169	Student
3	95	790	23	62	Male	170	Student
4	91	680	22	54	Male	168	Student
5	89	910	22	57	Male	171	Student
*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*
99	93	960	22	60	Male	170	Student
100	90	830	23	56	Male	167	Student

Schemes in machine learning on training data will be carried out several division schemes such as 90:10, 95:5, 99:1, 98:2, 97 :3, 96:4, 94:6, 93:7, 92:8, 91:9. The machine learning results obtained from the training data are shown in Table 2.

Table 2. Machine learning scheme

No	Skema	Training	testing	Train score	Test Score
1	99:1	99	1	54,5%	100%
2	98:2	98	2	54,08%	100%
3	97:3	97	3	54,6%	66,66%
4	96:4	96	4	53,12%	50%
5	95:5	95	5	52,26%	40%
6	94:6	94	6	52,12%	50%
7	93:7	93	7	54,34%	37,5%
8	92:8	92	8	54,34%	37,5%
9	91:9	91	9	53,84%	44,44%
10	90:10	90	10	55,55%	40%

The results of the analysis seen from table 2 state that there is a significant difference in results between the 99:1 and 92:8 schemes with a difference of 62.5%. From the results of table 2 it can be explained that in the 90 scheme: 10 get an accuracy rate of 40%, scheme 91: 9 get an accuracy rate of 44.44%,, scheme 92: 8 get an accuracy rate of 37.5%, scheme 93: 7 get an accuracy rate of 37.5%, scheme 94: 6 get an accuracy rate of 50%, scheme 95: 5 get an accuracy rate of 40%, scheme 96: 4 get an accuracy rate of 50%%, scheme 97: 3 get an accuracy rate of 66.66%%, scheme 98: 2 get an accuracy rate of 100%, scheme 99: 1 get an accuracy rate of 100%. Of the 10 schemes obtained the best results on machine learning schemes in scheme 99: 1 scheme with 100% accuracy rate and 54.5% train score. Figure 2 Line diagram related to machine learning results on 100 train data.

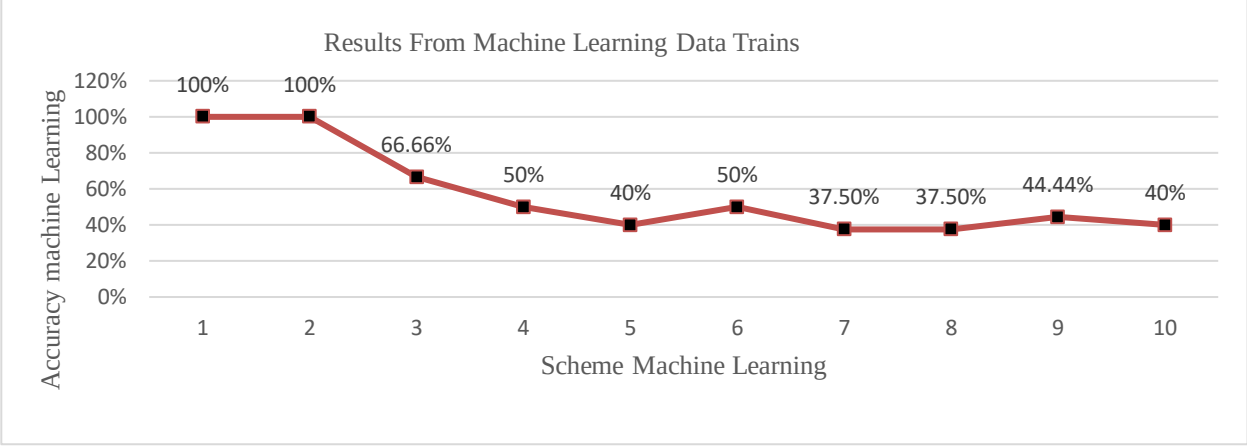

Figure 3. Machine learning results diagram on 100 train data

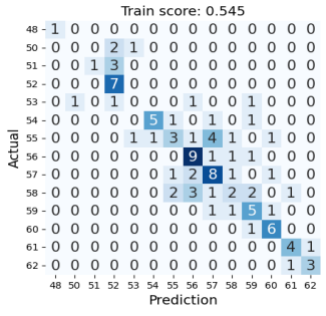

Figure 4. Confusion matrix result of 99:1 scheme

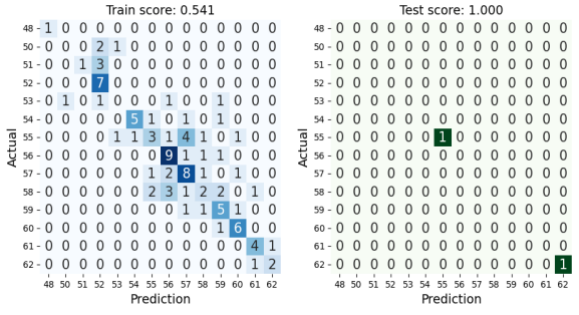

Figure 5. Confusion matrix result of 98:2 scheme

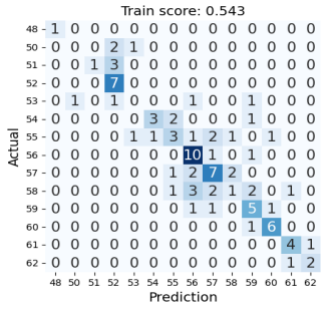

Figure 6. Confusion matrix result of 93:7 scheme

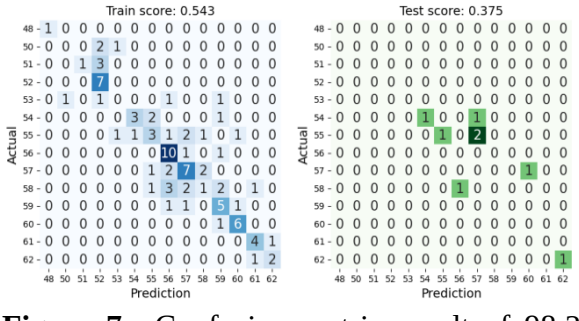

Figure 7. Confusion matrix result of 98:2 scheme

DISCUSSION

The results showed that the 98:2 learning model scheme and the 99: 1 learning model scheme gets 100% accuracy value during training. This is in accordance with the theoretical concept with the naïve bayes treatment carried out several times until the highest accuracy score is obtained in machine learning using the native bayes algorithm. The 100 data will be divided into training data and test data. At least with the best scheme of 90% training data and 10% testing data and several treatment schemes

to get the highest accuracy value (Burhaein, et al, 2023).

Based on the main scientific foundation in the field of sports and technology, the research results can be concluded that the machine learning data train expert system using the naïve bayes algorithm can be used for testing using new data with the highest and best accuracy. The limitations of this research are still up to the machine learning process which is the main part of the expert system and the display still uses native desktop-based. The advantage is that the expert system with the naïve bayes algorithm can classify quickly, efficiently and does not require internet access so that it can be implemented anywhere and anytime.

Research up to the machine learning stage in artificial intelligence, where the results of machine learning as scientific work belonging to (Sreemathy et al, 2023) are used as a reference in the use of new data for the classification of the distance of the ball kick.

Conclusions

The conclusion is that the accuracy level of the expert system training data using the naïve bayes algorithm to measure the distance of the ball kick gets the best accuracy in training data learning with an accuracy score of 100%. The training data learning model used uses 99 schemes and test 1 and 98 and test 2. The accuracy level of expert system training data using the naïve bayes algorithm is declared accountable. The limitations of this study are the research dataset for only 100 participants and other variables that were not included such as kick angle, wind direction speed, field conditions, and body balance when kicking the ball. Contributions to future research are testing using new data and adding participants and adding new variables to get better accuracy results when learning training data.

ACKNOWLEDMENT

The authors would like to express their deepest gratitude to Sekolah Sepak Bola Indonesia Muda Kebumen as the author's partner and Yogyakarta State University for the study of sports coaching in the doctoral program. Deep gratitude is also extended to all parties involved in this research.

Conflict of Interest

We declare that we are not involved in any conflict of interest in this and other scientific articles.

Ethics Statement

This research was conducted in accordance with the Helsinski Declaration. Ethical approval of this study was obtained from Yogyakarta State University on May 15 2024 and numbered 054/A/VI/2024 Ref. 0626118703, 2024

Author Contributions

Research Design, YFI, CCVL; Data Collection, YFI,AF, IPW, and PM; Statistical Analysis, RL, DT, and AF; Data Interpretation, RL, DT, and AF; Manuscript Preparation, YFI, AF, IPW, and PM; Literature Search, YFI, CCVL, AF, IPW, and PM. All authors have read and approved the published version of the manuscript.

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