IMPLEMENTATION OF NAÏVE BAYES METHOD TO DETERMINE THE GOALKEEPER'S ACTION ON PENALTY KICK SIMULATION GAME

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ABSTRACT

Games penalty kick is performed with a free-kick right in front of goalkeeper without be hindered by anyone. This stylish game genre sports game, a genre of games that were created from the existing sports real late. One of a kind research offers a sports genre game is a game of table tennis. AI (Artificial Intelligence) that is applied to the NPC to predict the direction of the blow the ball in the game ping-pong is N-Gram method. The predicted direction i.e. left, right, and Center. The blow of the player are stored in a data structure queue (queue). The problem is if the data structure queue is still empty, then the NPC would predict a random direction. Therefore the method of N-Gram less than optimal for applied research. Thus researchers using methods of naïve bayes applied on NPC'S goalkeeper to predict the direction of the ball so that it can acquire the action that will be performed. Naïve bayes method is one method that uses the techniques of classification that refers to an existing training data, so that the NPC does not predict the direction of the goalkeeper the ball randomly but rather naïve bayes classification based on the results.

The design of the system in this game is to use the agile method and built using object-oriented analysis with UML tools to him. The making of this game using the software Unity. Testing this game using blackbox testing, and testing methods of naïve bayes to test its accuracy.

The test results of this game showed that the functionality of the game goes well and the results of the testing methods of naïve bayes can be applied on the NPC goalkeeper with a level of accuracy in taking action of 77,78% with 21 out of 27 true prediction rule has been made.

Keywords : algorithm, naïve bayes, game penalty kick, artificial intelligence

1. INTRODUCTION

Penalty Kick is a game made with the free kick right in front of the goalie without being hindered by anyone. This game sports game genre, which is one of the genres of games created from the existing sports real life. One study of similar genre of sports game is a game of table tennis. Where in the table tennis game N-Gram method applied on NPC ball to predict the direction of the blow performed by the player. A predicted direction is left, right, and center. The blow of the player is stored in a data structure queue (queue). The problem is that if the data structure of the queue is empty, then the NPC will predict random direction [1]. Therefore, the N-Gram method less than optimal to be applied in this study. Therefore we need a method to predict the direction so that the NPC goalkeeper can specify the action exactly the way the classification of the data traning before the new data are input parameters.

One method is a method of naïve Bayes classification. Naive Bayes classification method is a method of probability and statistics raised by the British scientist Thomas Bayes, which predict future opportunities based on the experience of earlier and became known as Bayes theorem. Naive theorem is combined with an attribute condition in which it is assumed to be independent. Naive Bayes classification is assumed that there is or not a particular characteristic of a class has nothing to do with the characteristics of other classes. [2].

Therefore, in this study will be implemented naïve Bayes method as AI (Artificial Intelligence) to specify the action NPC goalkeeper in predicting the direction of the ball is kicked by a player. The input parameters in the form of direction, height and power of the kick. Of the three parameters then there are nine ball to be predicted by the NPC goalkeeper namely lower left, center-left, upper left, lower middle, middle - middle, tegah top, bottom right, right center, and right. For the classification of the three input parameters are naïve Bayes method then takes the data traning before, and the new data is in the form of input parameters such as the direction of the ball, high ball, and the power of the kick.

Based on the explanations that have been described previously, it is expected that the naïve Bayes method is applied to the NPC goalkeeper can take appropriate action and optimal in predicting the direction of the ball is kicked by a player.

2. RESEARCH CONTENTS

2.1 *Game Penalty Kick*

Game penalty kick is a game made with the free kick right in front of the goalie without being hindered by anyone. This game sports game genre, which is one of the genres of games created from the existing sports real life. Here is one example of game penalty kick that already existed before, can be seen in Figure 1.



Figure 1 Example of Game Penalty Kick

Based on the example of game penalty kick that has existed in this study there are three input parameters, namely the direction of the ball, high ball, and the strength of the kick that will be used for classification methods naïve Bayes, while goalkeeper act as NPC (non - player character). NPC is a character in the game is fully controlled by a computer and can not be played by the player. Therefore, it takes AI (Artificial Intelligence) against NPC goalkeeper in predicting the direction of the ball is kicked by a player so the goalie can take action.

2.2 Naïve Bayes Method

Naïve Bayes method is one of the methods contained in the classification techniques. Naïve Bayes classification method is a probability and statistics put forward by the English scientist Thomas Bayes, which predict future opportunities based on previous experience that is known as Bayes theorem. Bayes decision theory is a fundamental statistical approach to pattern recognition (pattern recognition). This approach is based on the quantification of trade-offs between the various classification decisions using probability and costs or consequences of the decision - the decision [2]. The following is a Bayesian approach for the estimation of the probability that of the equation 2.1 :

$$P(a_i \mid v_j) = \frac{n_c + mp}{n + m} \qquad (2.1)$$

Remarks :

n : The amount of data traning where $v = v_j$.

n_c : The amount of data traning where $v = v_j$ dan $a = a_i$.

P : *Prior* estimate for $P(a_i \mid v_j)$.

m : The sample size is equivalent.

The common method used to select the P value if there is no other information is the assumption of uniformity, that is, if there are K values may then P = 1 / k. If m is zero then the m-estimate will be equivalent to nc / n. If n and m are both non-zero, then the fraction observed were nc / n and the prior probability p will be combined according to the weight m. So why am called the sample size is equivalent to that in the equation 2.1 occurred reinforcement actual observation n m with an additional virtual samples distributed according to p. Bayes rule can be specified as follows:

If P (V1 | x) <P (v2 | x), then x is classified as V2.

An explanation of the results, naïve Bayes method is one of the methods that exist in the classification techniques, so in this study, the classification is based on three input parameters, namely the direction of the ball, high ball, and the power of the kick. The results of which will determine the classification of future action to be taken by the NPC goalkeeper. So in this research will be implemented naïve Bayes method to determine the NPC action simulation game keeper in penalty kick.

2.3 Game analysis

Analysis of the game is the decomposition explanation of parts - parts of the game that will be designed. Explanation especially for the parts - part in the game which will be applied the algorithm.

Games that will be designed is a game penalty kick. The game is built in prototype form. Based on a penalty kick game that already exist, to kick the ball there are three input parameters, namely the direction of the ball, high ball and kick strength. While the algorithm is applied in this study is naïve Bayes method. This algorithm is applied to the NPC goalkeeper. Naïve Bayes method is one method of applying classification techniques. Because the method of applying the naïve Bayes classification techniques, it is in this thesis is based on the value of linguistic classification of three input parameters, namely the direction of the ball, high ball and kick strength. The linguistic value of the parameter direction of the ball that is left, center, and right. High linguistic value of the parameter ball is high, medium, and low. Linguistic value of the parameter kick strength is strong, normal, and weak.

Game penalty kick to be built consists of two main processes, namely the training process naïve

Bayes and naïve Bayes classification. Naïve Bayes training process which is a process that is carried out to form a probabilistic model of the data traning for every action NPC goalkeeper. The naïve Bayes classification process is to classify new data that will be used to determine the action to be taken by NPC goalkeeper. In Figure 2 is a flowchart of game penalty kick.

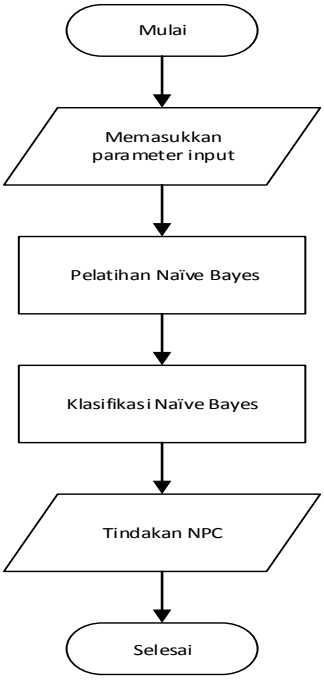


Figure 2 Flowchart Penalty Kick Game

To determine the position of a ball point obtained based on horizontal and vertical directions. For the horizontal direction is left, center, and right. As for the vertical direction is lower, middle, and on the importance of the position of the ball is the top left, middle left, lower left, upper middle, middle - middle, lower middle, upper right, center-right, and bottom right. As an illustration of the position of the ball can be seen in Figure 3.

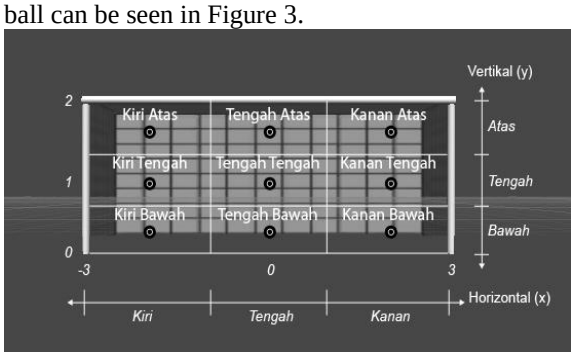


Figure 3. Illustration of Ball Point

2.4 Analysis Input

Analysis of input in this research is to analyze the input parameters to the game a penalty kick, these parameters are parameters of direction, height and power of the kick and the rule or rules made in game penalty kick to be used as reference data, the training of some of the existing rules.

2.4.1 Parameter Direction

Player can kick the ball with the power input 3 linguistic values are weak, normal and strong. As for the details of which can be seen in Table 1.

Table 1 Parameter Direction

DIRECTION	POINT COORDINATE X
Left	-3 s.d -1
Middle	-1 s.d 1
Right	1 s.d 3

The point coordinates **x** serve to determine the direction of the ball. While the value of linguistic left, center, and right direction serves as an input parameter that is used for naïve Bayes classification.

2.4.2 Parameter Height

Player can input a ball with 3 high linguistic value, low, medium, and height. As for the details of which can be seen in Table 2:

Table 2 Parameter Height

HEIGHT	POINT COORDINATE Y
Height	1.5 s.d 2
Medium	0.5 s.d 1.5
Low	0 s.d 0.5

The point coordinate **y** is used to determine the height of the ball. While the linguistic value of high, medium, low and height functioning as input parameters used for classification naïve Bayes.

2.4.3 Parameter Power

Player can kick the ball with the power input 3 linguistic values are weak, normal and strong. As for the details of which can be seen in Table 3:

Tabel 3 Parameter Power

POWER	RANGE
Strong	56 s.d 60
Normal	51 s.d 55
Weak	45 s.d 50

The range kicks force serves to determine the strength of the kick. While the value of linguistic strong, normal, and weak force serves as the input parameters used for classification naïve Bayes.

2.4.4 Rule

Rule is a rule which made the penalty kick in the game is to be used as reference data, the training of some of the existing rules. Rule is also used for comparison of the results of naïve Bayes classification method.

2.5 Analysis Mehods

2.5.1 Training Process Naïve Bayes

Training Process naïve bayes which is a process that is carried out to form a probabilistic model of the data traning for every action NPC goalkeeper. The training process naïve Bayes flowchart can be seen in Figure 4.

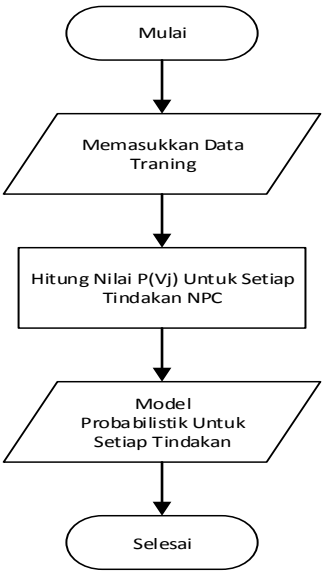


Figure 4 Training Process naïve bayes

2.5.2 Klasification Process Naïve Bayes

Having obtained or carried out the training process, the next step is to test the classification process NPC goalkeeper with test data in the form of player input parameters such as parameter the direction, height and power of the kick. Where the results of this classification later to determine the action to be taken by NPC goalkeeper. The flowchart for the process of naïve Bayes classification can be seen in Figure 5.

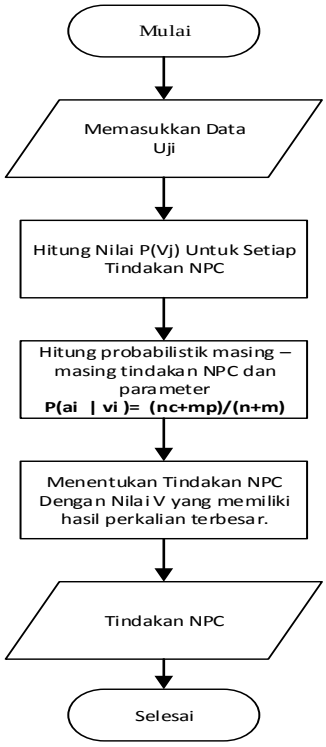


Figure 5 Klasification Process Naïve Bayes

2.6 Functional Needs Analysis

Analysis of functional requirements describe the activities to be implemented in a system and describes the system requirements necessary for the system to run well and according to need. Analysis of functional requirements are modeled using UML (Unified Modeling Language). The functional requirements to be modeled includes use case diagrams, use case scenarios, activity diagram, sequence diagram, and class diagram.

2.6.1 Use Case Diagram

Use case diagrams are used to describe the functionality of a system, which describes the interaction of one or more actors to the functionality of the system. Use case diagrams on a penalty kick game can be seen in Figure 6.

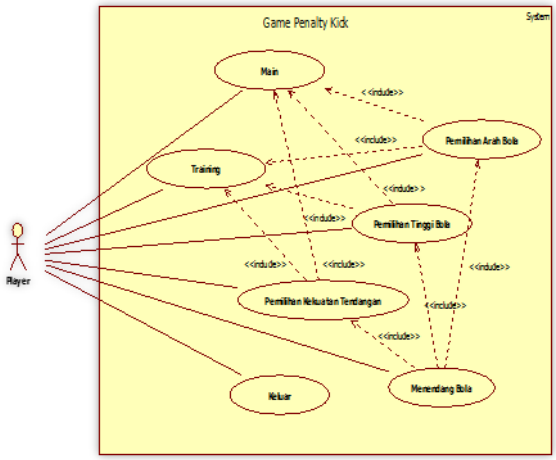


Figure 6 *Use Case Diagram Penalty Kick Game*

2.6.2 Activity Diagram

Activity diagram illustrates the various flow activity in the system that is being designed, how each flow starts, decision that might occur, and how they ended. Activity diagrams can also illustrate the parallel processes that may occur in several executions. Here is one activity diagram on this research can be seen in Figure 7.

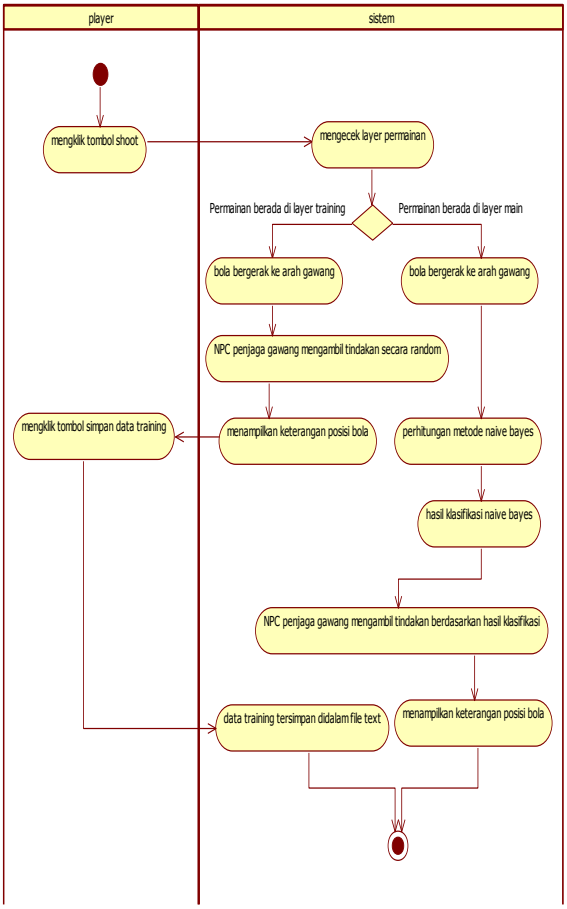


Figure 7 *Activity Diagram Kicking Ball*

2.6.3 Class Diagram

Class diagram describing the structure of the system in terms of defining classes were created to build the system. Class diagrams that exist on a penalty kick game can be seen in Figure 8.

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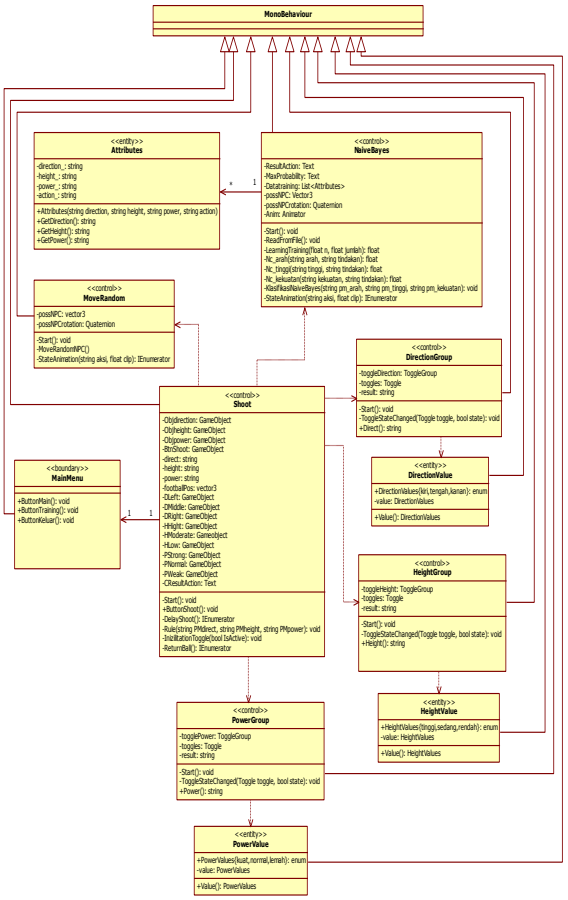


Figure 8 Class Diagram Penalty Kick Game

2.7 Implementation And Testing Results

2.7.1 Implementation Interface

An interface implementation steps being taken for the implementation of the analysis into the application interface. The following is an implementation of interface design which has been made into an application.

2.7.1.1 Main Menu Interface

The main menu interface is the main menu view when a player opens the game application. Views from the main menu interface can be seen in Figure 9.



Figure 9 Main Menu

2.7.1.2 Games Menu Interface

Game menu interface is a display when the player is within the game area, where in the main menu of this NPC goalkeeper has been given

artificial intelligence that is naïve Bayes methods for NPC goalkeeper can specify the actions to be taken when a player kicks. Views from the main menu interface can be seen in Figure 9.



figure 9 Games Menu Interface

2.7.1.3 Training Menu Interface

Training menu interface is a display used to enter training data, where in the training menu NPC goalkeeper has not given artificial kecerdasaran or random act. Display of training menu interface can be seen in Figure 10.



Figure 10 Training Menu Interface

2.7.2 Testing

Tests on a penalty kick game application is done with black box testing and testing methods. Black box testing focuses on finding program errors of the functionality, while testing method focuses on the method used.

2.7.2.1 Black Box Testing

The process of black box testing is performed to determine whether the data entered is as expected. The following is the result of black box testing of any existing functionality on a penalty kick game can dilhat in Table 4.

Table 4. Black Box Testing Results

The Component Tested	Input	Observation	Conclusion
Main functionalities	Click on the main menu	Can display games area	[√] Accepted
functionalities Training	Click the training	Can display training area	[√] Accepted
Selection functionalities Direction Ball	Selecting the parameter direction of the ball: Left	Can display the direction choice of the ball is left	[√] Accepted
	Choosing the direction of the ball parameters: middle	Can display the direction of the ball is the middle choice	[√] Accepted
	Selecting the parameter direction of the ball: right	Can display the direction of the ball that is the right choice	[√] Accepted
High Electoral functionalities Ball	Choosing a height ball parameters: height	Can display heightball option is height	[√] Accepted
	Choosing a height ball parameters: average	Can display heightball option that is being	[√] Accepted
	Choosing a height ball parameters: Low	Can display height ball, low selection	[√] Accepted
Selection functionalities Strength kick	Choosing the strength parameters kicks: strong	Can display the power option that is strong kick	[√] Accepted
	Choosing kick strength parameters: normal	Can show the power of the kick option that is normal	[√] Accepted
	Choosing kick strength parameters: weak	Can display the strength option kicks are weak	[√] Accepted
functionalities Kicking Ball	Click the shoot	The ball can move toward the goal according to	[√] Accepted

		the input parameters of blood, height, and power of the kick.	
functionalities Out Of Game	Click the menu out	Can exit the app game	[√] Accepted

From the black box test results that can be concluded that the functionality runs as expected.

2.7.2.2 Testing Method

Testing method is done by calculating the degree of accuracy of naïve Bayes methods and determining the value of its error in determining the NPC actions by referring to the rule or rules that have been made. The accuracy of testing done by inserting the same problem that the existing training data and test data that does not exist in the training data is drawn from the rule that has been made. To determine the classification results are true or not based on the rule that has been made, then conducted trials of 27 rule or rules made where there are 18 9 training data and test data.

As for count accuracy using the equation (2.6).

$$\text{Accuracy} = \frac{\text{Amount of data correctly}}{\text{Amount of overall data}} \text{x } 100\ \%$$

Here are the results of testing training data can be seen in Table 5.

Table 5 Results of Testing Data Training

Rule Based Training Data					Testing Results (NPC Actions)
Data -	**Direction**	**Height**	**Power**	**Action**	
1	Left	Height	Strong	top left	top left
2	Left	Height	Normal	top left	top left
3	Left	Moderate	Strong	middle left	middle left
4	Left	Moderate	Normal	middle left	middle left
5	Left	Low	Normal	lower left	lower left
6	Left	Low	Weak	lower left	lower left
7	Middle	Height	Strong	Top Middle	Top Middle
8	Middle	Height	Normal	Top Middle	Top Middle
9	Middle	Moderate	Strong	Middle Middle	Middle Middle
10	Middle	Moderate	Normal	Middle Middle	Middle Middle
11	Middle	Low	Normal	Down Middle	Down Middle
12	Te Middle ngah	Low	Weak	Down Middle	Down Middle
13	Right	Height	Strong	Top right	Top right
14	Right	Height	Normal	Top right	Top right
15	Right	Moderate	Strong	Middle right	Middle right
16	Right	Moderate	Normal	Middle right	Middle right
17	Right	Low	Strong	Bottom right	Bottom right
18	Right	Low	Normal	Bottom right	Bottom right

From the test results of existing training data in Table 5 can be calculated level of accuracy as follows :

$$\text{Accuracy} = \frac{18}{18} \text{x } 100\ \% = 100\ \%$$

While following the test results of test data can be seen in Table 6.

Table 6. Results of Test Data Test

Rule Based Test Data					Testing Results (NPC Actions)
Data	**Direction**	**Height**	**Power**	**Action**	
1	Left	Height	Weak	middle left	top left
2	Left	Moderate	Weak	lower left	middle left

3	Left	Rendah	Strong	lower left	lower left
4	Middle	Height	Weak	Middle Middle	Top Middle
5	Middle	Moderate	Weak	Down Middle	Middle Middle
6	Middle	Low	Strong	Down Middle	Down Middle
7	Right	Height	Weak	Middle right	Bottom right
8	Right	Moderate	Weak	Bottom right	Middle right
9	Right	Low	Weak	Bottom right	Bottom right

From the test results of test data listed in Table 6 can be calculated level of accuracy as follows:

$$\text{Accuracy} = \frac{3}{9} \text{x } 100\ \% = 33{,}33\ \%$$

From the test results the training data and test data, can be calculated the total accuracy is obtained based on the rule that was created as follows:

$$\text{Accuracy} = \frac{21}{27} \text{x } 100\ \% = 77{,}78\ \%$$

From the results of tests performed, it can be concluded that the level of accuracy of 27 rules that have been created in which the accuracy of naïve Bayes method in determining the NPC actions goalkeeper amounted to 77.78%.

3 CLOSING

3.1 Conclusion

Based on research on the implementation of naïve Bayes method for determining actions goalkeeper NPC can be concluded that the naïve Bayes method can be applied to the NPC goalkeeper with promptness in taking action amounted to 77.78%.

3.2 Suggestion

As for the suggestion after researchers conducted a study and analyze the system, and for those interested to develop this application in the future, the researchers tried to give the following advice:

1. For height parameters need to be supplemented ball linguistic variable is a variable very height.
2. To kick strength parameters necessary to change that classification is based on a numerical rating of the power of the kick.

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