Implementation of Genetic Algorithms in The Application of Car Racing Games

Ade Pujianto
Informatika, Fakultas Ilmu Komputer, Universitas Amikom Yogyakarta
Email: ade.pujianto@amikom.ac.id

Article Info	ABSTRACT
	Rice The car racing game is a game that has always been popular from the past until now. where this game has lots of interesting gameplay, especially when adding artificial intelligence (AI) which makes the gameplay more challenging because the game is more dynamic with various levels of difficulty. However, most research on the application of artificial intelligence (AI) to the gameplay of car racing games is only limited to implementing algorithms without optimizing or improving the algorithm. Therefore, this research will optimize the artificial intelligence (AI) algorithm. The algorithm used in this study is a genetic algorithm, where the genetic algorithm is an adaptive algorithm that uses the concept of genetic mutation through a process of genetic selection, genetic crossover and genetic mutation. The implementation of the genetic algorithm is carried out through a training configuration using the Violated Directed method for mutations, the extended intermediate method for crossover and the selection method used is elitism. Optimization is done by increasing the learning rate and momentum process to speed up the training process and increase the accuracy of the algorithm. The conclusion of the genetic algorithm optimization is to accelerate the training time process by 1.40151 ms, shorten the mutation process by 97 processes and increase the accuracy by 5.4%.

Corresponding Author:
Ade Pujianto,
Informatika, Fakultas Ilmu Komputer,
Universitas Amikom Yogyakarta
Email: ade.pujianto@amikom.ac.id

1. INTRODUCTION

Games or games are one of the entertainment media to get rid of boredom, apart from eliminating boredom, games also exist Other positive impacts such as increasing brain work such as strategy games, logic games and other games to sharpen the brain, games can also increase social feelings such as playing with many friends, working together and increasing the spirit of sportsmanship for the players. The game or the game itself is not only played in traditional ways such as playing games and meeting directly with other players but also with technological developments such as computer or smartphone games [1].

It cannot be denied that technology has a very big influence on the way of life of humans. Since humans have to move from place to place in search of food sources to when we only order food online, it's all thanks to technology. Like wise in the world of games, from the Nintendo era with simple graphics and having to connect to a TV until now we can play games with luxurious graphics with only a mobile phone that can be carried anywhere. Thanks to the Android, which is open-source code, so smartphone makers can use and use Android according to their needs at no cost which causes the final price to be relatively cheap, so that the product can be reached by all classes. As of January 2020, Android was recorded to have a world market share of 84.75% for mobile operating systems [2].

The racing game genre is a game or game that is very much in demand by game lovers, the gameplay is easy to play so that many gamepun players must have played games with this genre, various characters such

as car shapes, racer characters and interesting arenas. The circuit also causes players to play games of this genre. This game wants to play a lot of games with this racing genre, in addition to easy gameplay and an attractive appearance, racing games can also be used as competitive games by racing with other players, players can compete by racing to finish the fastest finish. line or by comparing the fastest time to reach the finish line [3].

In addition to competitive gameplay with other players, the development of artificial intelligence (AI) technology can also be used to increase the variety of competitive games with players against computers or artificial intelligence (AI), the application of artificial intelligence (AI) can also be implemented for the difficulty level of players in completing the game. game. One form of artificial intelligence (AI) uses artificial intelligence in games, where the algorithm is adaptive so it can work very well to improve artificial intelligence (AI) in the gameplay of this racing game [4].

Anita and Veri (2013) framed and made scrabble word games using a genetic algorithm. In this research, the output of a game that is able to present a word search game is through the application of a genetic algorithm. Genetic algorithm that is implemented through the configuration of the mutation method used is Random Mutation and the selection method uses the method elitism. The differences in this study are the application of genetic algorithms through the configuration of the method Violated Directed for mutations, the method extended intermediate for crossovers and the addition of optimization of learning rate and momentum during algorithm training [5].

Johan, Kristo and Liliana tried to apply genetic algorithms in making troops in the Battle of Batavia game. The result of this research is the Battle of Batavia strategy genre game with genetic algorithms, genetic algorithms are used as enemy troops (AI). In this study, the implementation of a genetic algorithm with configuration process crossover using the extended intermediate crossover method, the mutation method using random mutation and the selection method using elitism selection. The difference in this study is the application of genetic algorithms through the configuration of the application of the method Violated Directed for mutations and the addition of optimization of learning rate and momentum during training and evaluation of fitness values [6].

Wage, Esmeralda and Rezki researched to optimize the action of non-player characters (NPCs) in a genetic algorithm for playing card games. The result of this research is that the application of genetic algorithms can produce a Playing Card Game with NPCs that can determine the action based on the optimal score or the determined difficulty level. In this study, the implementation of a genetic algorithm with configuration method one-cut point crossover and the mutation method used is reciprocal exchange mutation and the selection method used is elitism. The difference in this study is the application of genetic algorithms through the configuration of the method Violated Directed for mutations, the method extended intermediate for crossovers and the addition of optimization of learning rate and momentum during training [7].

Because most of the research carried out the application of genetic algorithms without optimizing the algorithm, therefore researchers tried to optimize the algorithm by increasing the learning rate and momentum to speed up the process and improve the genetic algorithm in the racing car game.

2. RESEARCH METHOD

In the method or flow section of this research, step-by-step details of the research are made in detail. The research flow in general uses the indie development method where the development method is used by indie game makers. The stages contained in the indie development method are as shown in Figure 1 with the following explanation:

a. Initialization

At the beginning of the application of the genetic algorithm requires initialization of the initial population, where at this stage the number of chromosomes in a population is determined, determining the desired gene representation, determining the fitness threshold and the maximum number of iterations and determining the probability of crossover and genetic mutation.

b. Evaluation of Fitness

This stage is a stage after the initialization process, at this stage the calculation of the fitness value through the appropriate fitness function is carried out. At this stage, optimization is also carried out through the addition of anearning rate and momentum to speed up the training or evaluation process.

c. Parents

Of parents after obtaining the optimal fitness value, the next step is choosing the parents, where at this stage the number of pairs of parents who will be genetically crossing is determined. The parent selection method used is the method random selection where the selection will be done randomly.

d. Crossover

The crossover process is the most important stage in the implementation of genetic algorithms, where at this stage the process of making new children or chromosomes will be carried out. The type of population model to be used is a steady state where only a few new chromosomes will be made, one or two chromosomes that will replace the old chromosomes. The crossover method used is the method extended intermediate crossover.

e. Mutation

The mutation stage is the result of the crossover stage where the mutation is the genotype of the gene (changing the value of the gene), mutation is carried out through a single point mechanism or through many points. The mutation method used is the method Violated Directed.

f. Selection

The selection stage is the stage for obtaining an optimal new population, where at this stage unimportant chromosomes are replaced by new, more optimal chromosomes. The selection method used is the method Fitness Based selection with the principle of elitism.

g. Results

This stage is the final stage where if the iteration conditions are met the chromosomes with the best fitness values will be used as a new genetic result.
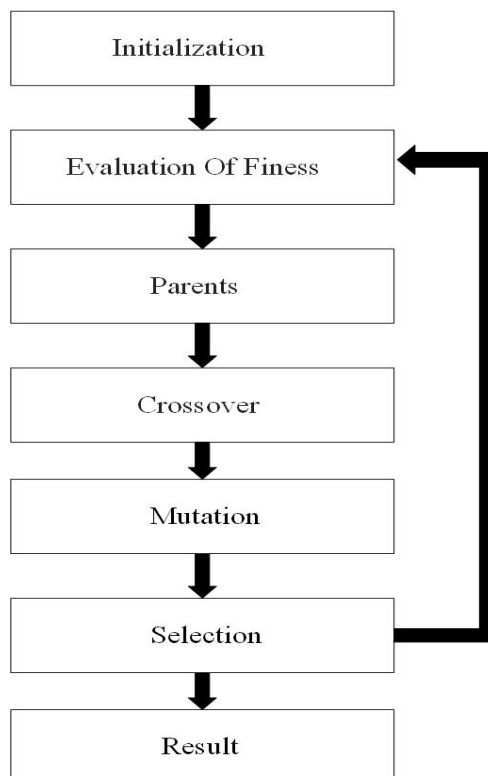

Figure 1. Research Method

3. RESULT AND ANALYSIS

In this test game, algorithm testing will be carried out by making all the possibilities that will appear and choosing the best or decisions for the steps to be taken by AI (Computer) to beat the players according to the level pre-selected difficulty. The results of this algorithm test can be seen as follows:

3.1. Application Testing

In application testing will be tested on the game's gameplay configuration at 3 levels, namely easy, medium and hard with test details as follows:
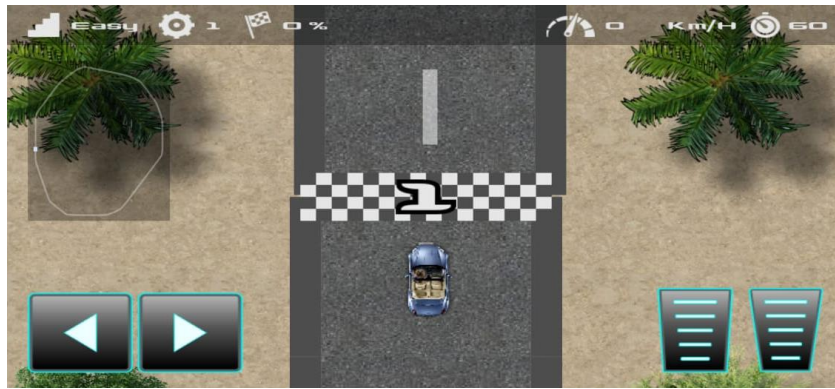
Figure 2. Easy Gameplay

In Figure 2 you can see the results of making an easy level race track where the path is made to have a slight bend angle with an easy difficulty level so that players can easily complete this mode, the game in this mode it uses a maximum population configuration of 200, a maximum generation of 500, a mutation rate of 0.03f, a path length of 80, a path length per step of 1000, a min distance of 40, a min distance. between points 1100, maximum turns of 500, diversity of turns 150, time 60.
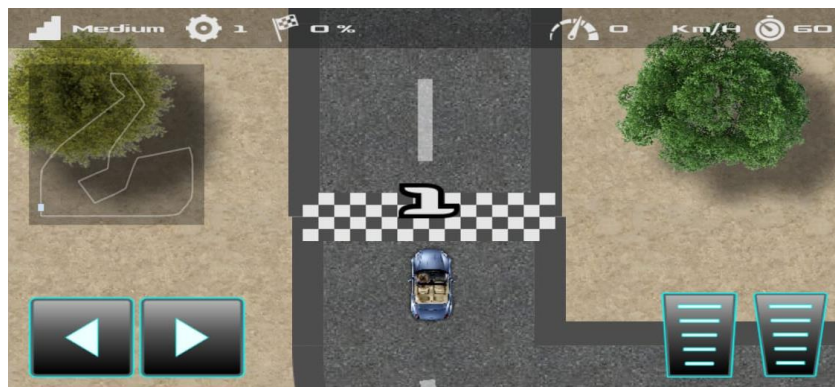

Figure 3. Medium Gameplay

In Figure 3, you can see the results of making a medium level race track where the line is made to have a bend angle with a moderate difficulty level so that players will experience medium difficulty in this mode, namely the game in this mode uses a maximum population configuration of 200, a maximum generation of 500, mutation rate 0.03f, path length 80, path length per step 1000, min distance 40, min distance between points 1100, max turn 1000, turn diversity 150, time 60.
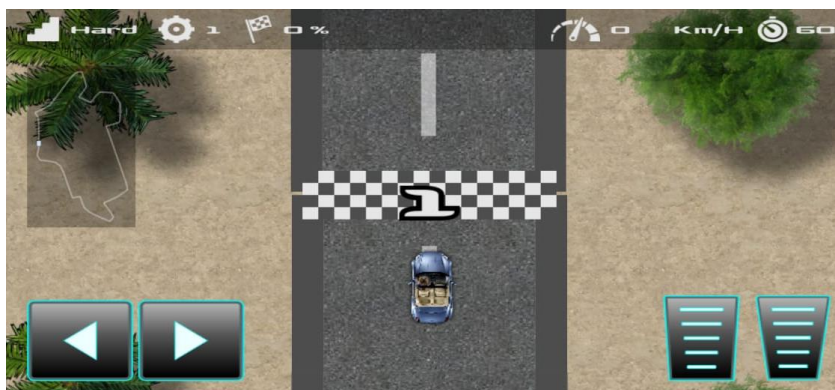

Figure 4. Hard Gameplay

In Figure 4 you can see the results of making a hard level race track where the path is made to have a bend angle with a difficult difficulty level so that players will have difficulty when they want to finish in this mode. The game in this mode uses a maximum population configuration configuration of 200, maximum generation 500, mutations. rate 0.03f, track length 80, track length per step 1000, min distance 40, distance min. between 1100 points, 1500 max turns, 150 turns diversity, time 60.

3.2. Algorithm Testing

Testing for genetic algorithm testing in racing car games, through configuration mechanism the method Violated Directed for mutations,method extended intermediate for crossover, method extended intermediate for crossover, method random selection where parent selection, The selection method is the method of selectionFitness Based with principle Elitism and learning rate and momentum to accelerate the training or evaluation process.
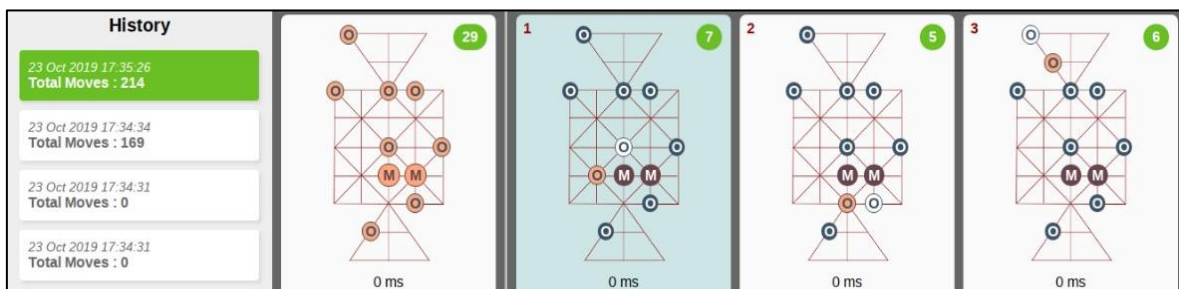

Figure 5. Implementation of Genetic Algorithms in the Application

Figure 5 illustrates the possible results or patterns that will be carried out by AI (computer). Where from the various possible results the best AI (Computer) path will be selected in determining the decision to make the path.

Algorithm performance testing is carried out through 3 testing mechanisms, namely testing the training time (ms), the number of mutation processes and algorithm accuracy (%) with 500 iterations. With details on the performance of algorithm testing can be seen in Table 1, testing was carried out using Quick Testing before and after optimization.

Table 1. Performance of the Testing Algorithm

Remark	Time (ms)		Genetic Mutations (Cross)		Accuracy (%)	
	Before	After	Before	After	Before	After
Depth 100	0.00001	0.00001	0	0	86,13	90,76
Depth 200	1.00023	0.00420	169	167	86,89	91,29
Depth 300	2.01825	0.85310	256	259	87,25	91,93
Depth 400	3.36650	1.05600	312	308	88,02	92,65
Depth 500	4.18550	2.78399	498	401	89,34	94,74

4.   CONCLUSION

The final conclusion on the study of the application of genetic algorithms in car racing games, was carried out through the configuration of the method Violated Directed for mutations, the method extended intermediate for crossover, the method extended intermediate for crossover, the method random selection where the selection of parents, The selection method is the method of selectionFitness Based with principle Elitism and learning rate and momentum to accelerate the training or evaluation process.testing is performed using Quick Testing with a maximum of 500 iterations. In the test results, it was found that in the 500th iteration, the results of applying the genetic algorithm without optimization obtained a time performance of 4.18550 ms, the number of genetic mutations was 498 and an accuracy of 89.34%, while for genetic algorithms with optimization the results obtained time was 2.78399 ms, the number of genetic mutations was 401 and accuracy of 94.74%. Based on these results it can be concluded that the performance of the genetic algorithm with additional optimization learning rate and momentum can improve algorithm performance with a training time difference of 1.40151 ms, 97 mutation processes and an accuracy of 5.4%.

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BIBLIOGRAPHY OF AUTHORS

Ade Pujianto was raised and born in Pemalang, Central Java. He is a lecturer in the Department of Informatics, Faculty of Computer Science, Yogyakarta Amikom University. Completed his Masters degree at Amikom Yogyakarta University in 2019