

Evaluating AI constructed from Human Player's Behavior in Universal Fighting Engine

Souta Ando s1230166

Supervised by Maxim Mozgovoy

Abstract

In this study, we analyzed the numerical results calculated from the learning level of AI on each situation to construct the AI that is similar to the behavior of actual human. Speaking of each situation, we describe the most learning level by AI to adjust the difficulty of the opponent and recorded data for AI on Universal Fighting Engine.

1. Introduction

The technology of artificial intelligence is developing every year. It is mainly used as statistical analysis on almost companies and the operating by the computer in video or arcade games. There is a type of game that uses the computer by artificial intelligence such as racing, sports, fighting game. We are interested in artificial intelligence in the computer of fighting game. The purpose of this study is how to construct artificial intelligence in the computer that behaves like human in fighting game. First, we have to reflect action data what computer learns and analyzes from recorded data that are real human played in fighting game to computer to construct artificial intelligence in the computer that behaves like. In this paper, we will check whether the artificial intelligence of the computer in fighting game can be close to human behavior through the data what artificial intelligence in computer learns from player.

2. Method

2.1. behavior capture

Behavior capture is the method that is the structure that we need to make artificial intelligence of the computer to learn from data [1]. It is artificial intelligence of computer observes the behavior of player and automatically constructs data structure called knowledge base that consists of node that indicates each situation in game and the edge that indicates from current situation to another situation.

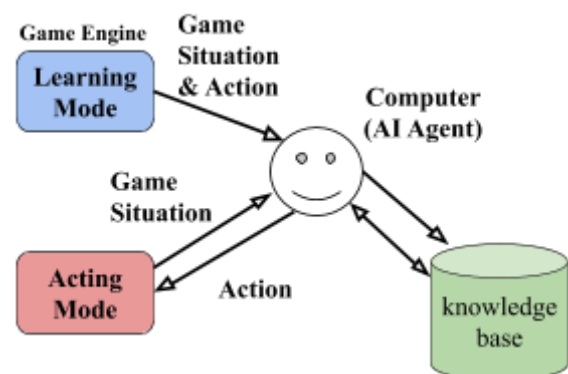


Figure 1 : The structure of behavior capture

2.2. Making playing data by player on UFE

In our experiments, We use Universal Fighting Engine what is the framework that is running on Unity to develop fighting game for indie developers or small companies [2]. I think this is helpful to construct the computer like human behavior because we can control the aggressiveness of opponent and the combo efficiency that is to attempt to read the chains of attacks by player and the difficulties of opponent what is running as computer such as easy, normal, hard and that computer takes minimum time to formulates its decision and execute it and save the playing data for checking how AI learns automatically.



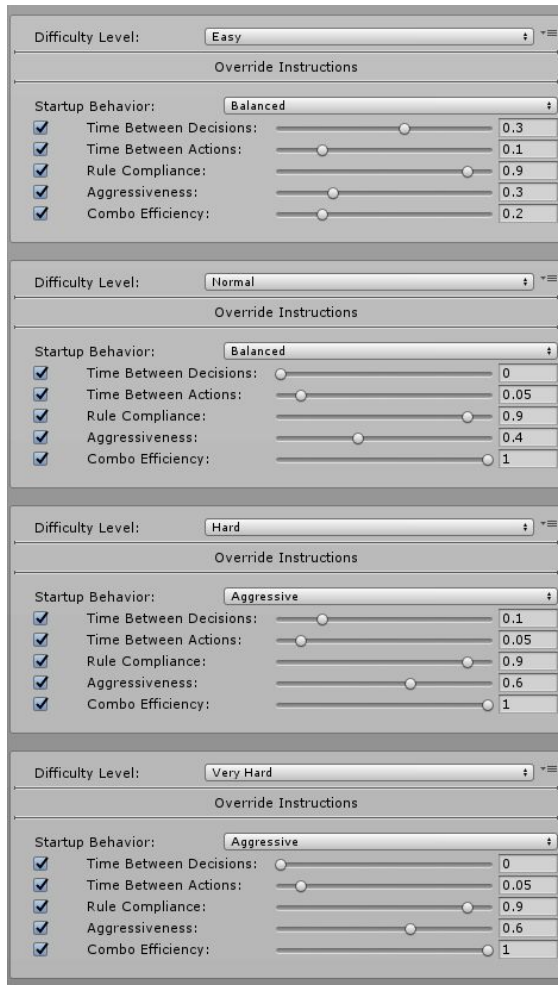


Figure 2. : Above: Universal Fighting Engine Below: Configuration of the parameter related to computer

2.3. Experimental Methods

We have an already developed AI what is constructing knowledge-base for it based on behavior-capture for the boxing game and we are testing it on Universal Fighting Engine and play with the computer adjusted three difficulties such as easy, normal, hard to get the learning levels that AI could learn from the actions of player because we need to check the difference of how difficulty for player from easy to had.

We increase automatic saved playing data on scripts and divided to every difficulties. So, We generated knowledge-based data from their scripts and recorded the learning levels of AI to make AI to learn playing data with different difficulties.

3. Results

3.1. The table description

We will explain Table 1, First, we could collect training sets consisting of 16 fighting matches between a human-controlled and built-in AI-controlled characters and we arranged their training sets by two on vertical columns.

Next, Speaking of the horizontal rows, **Z0** and **Z1** mean that AI could find the elements to find. Actually, **Z0** is more precisely and better than **Z1**. **ANF** stands for “**Action Not Found**” and means that AI could not find the elements to learn.

3.2. The experimental Results

Table 2 shows, it tends to increase the results of **Z0** and **Z1** that AI could learn and decrease “Action Not Found” that AI couldn’t learn. Speaking of the result about that AI could learn, **Z1** is more than **Z0** excepting for that AI learnt from playing data on difficulty of normal when training sets of knowledge base of the difficulty is hard at the first of training sets and **Z0** is more than **Z1** when the training sets of knowledge base of the difficulty is lower than the difficulty of playing data excepting for the playing data is normal and the training sets of knowledge base is easy. **Z1** is more than **Z0** when it is higher than the difficulty of playing data at the last of training sets. Accordingly, When training sets is increasing, the results that describe that AI could learn would be increased in general.

| | | | | | | |
|---------------|-------------|------------|-------------|-------------|-------------|--------------|
| training sets | normal (Z0) | normal(Z1) | normal(ANF) | hard (Z0) | hard (Z1) | hard(ANF) |
| easy 2 | 910 | 1388 | 852 | 914 | 1326 | 1291 |
| easy 4 | 1491 | 1298 | 361 | 953 | 1788 | 790 |
| easy 6 | 1514 | 1428 | 208 | 1107 | 2011 | 413 |
| easy 8 | 1654 | 1294 | 202 | 1425 | 1693 | 413 |
| easy 10 | 1715 | 1233 | 202 | 1438 | 1680 | 413 |
| easy 12 | 1726 | 1222 | 202 | 1450 | 1668 | 413 |
| easy 14 | 1836 | 1314 | 0 | 1464 | 1665 | 402 |
| easy 16 | 1872 | 1278 | 0 | 1464 | 1937 | 130 |
| training sets | easy (Z0) | easy (Z1) | easy(ANF) | hard (Z0) | hard (Z1) | hard (ANF) |
| normal 2 | 1018 | 1003 | 1511 | 694 | 1743 | 1094 |
| normal 4 | 1174 | 1210 | 1148 | 767 | 1862 | 902 |
| normal 6 | 1315 | 1117 | 1100 | 964 | 1713 | 854 |
| normal 8 | 1425 | 1007 | 1100 | 1016 | 2053 | 462 |
| normal 10 | 1630 | 1042 | 860 | 1033 | 2148 | 350 |
| normal 12 | 1630 | 1042 | 860 | 1061 | 2331 | 139 |
| normal 14 | 1781 | 1550 | 201 | 1286 | 2217 | 28 |
| normal 16 | 1792 | 1539 | 201 | 1342 | 2174 | 15 |
| training sets | easy (Z0) | easy (Z1) | easy(ANF) | normal (Z0) | normal (Z1) | normal (ANF) |
| hard 2 | 1046 | 1101 | 1385 | 757 | 733 | 1660 |
| hard 4 | 1207 | 1338 | 987 | 984 | 1218 | 948 |
| hard 6 | 1351 | 1385 | 796 | 998 | 1266 | 886 |
| hard 8 | 1546 | 1215 | 771 | 1046 | 1358 | 746 |
| hard 10 | 1560 | 1377 | 595 | 1189 | 1226 | 735 |
| hard 12 | 1589 | 1680 | 263 | 1298 | 1393 | 459 |
| hard 14 | 1622 | 1678 | 232 | 1298 | 1393 | 459 |
| hard 16 | 1827 | 1473 | 232 | 1429 | 1262 | 459 |

Table 1 the numbers of the results about learning by AI

| | | | | | | | |
|-------------|------------|-------------|------------------|-------------|------------|-------------|------------------|
| normal (Z0) | normal(Z1) | normal(ANF) | normal (Z0 + Z1) | hard(Z0) | hard (Z1) | hard (ANF) | hard(Z0 + Z1) |
| 28.89 | 44.06 | 27.05 | 72.95 | 25.89 | 37.55 | 36.56 | 63.44 |
| 47.33 | 41.21 | 11.46 | 88.54 | 26.99 | 50.64 | 22.37 | 77.63 |
| 48.06 | 45.33 | 6.6 | 93.4 | 31.35 | 56.95 | 11.7 | 88.3 |
| 52.51 | 41.08 | 6.41 | 93.59 | 40.36 | 47.95 | 11.7 | 88.3 |
| 54.44 | 39.14 | 6.41 | 93.59 | 40.73 | 47.58 | 11.7 | 88.3 |
| 54.79 | 38.79 | 6.41 | 93.59 | 41.06 | 47.24 | 11.7 | 88.3 |
| 58.29 | 41.71 | 0 | 100 | 41.46 | 47.15 | 11.38 | 88.62 |
| 59.43 | 40.57 | 0 | 100 | 41.46 | 54.86 | 3.68 | 96.32 |
| easy (Z0) | easy (Z1) | easy(ANF) | easy(Z0 + Z1) | hard(Z0) | hard(Z1) | hard(ANF) | hard (Z0 + Z1) |
| 28.82 | 28.4 | 42.78 | 57.22 | 19.65 | 49.36 | 30.98 | 69.02 |
| 33.24 | 34.26 | 32.5 | 67.5 | 21.72 | 52.73 | 25.55 | 74.45 |
| 37.23 | 31.63 | 31.14 | 68.86 | 27.3 | 48.51 | 24.19 | 75.81 |
| 40.35 | 28.51 | 31.14 | 68.86 | 28.77 | 58.14 | 13.08 | 86.92 |
| 46.15 | 29.5 | 24.35 | 75.65 | 29.26 | 60.83 | 9.91 | 90.09 |
| 46.15 | 29.5 | 24.35 | 75.65 | 30.05 | 66.02 | 3.94 | 96.06 |
| 50.42 | 43.88 | 5.69 | 94.31 | 36.42 | 62.79 | 0.79 | 99.21 |
| 50.74 | 43.57 | 5.69 | 94.31 | 38.01 | 61.57 | 0.42 | 99.58 |
| easy (Z0) | easy (Z1) | easy(ANF) | easy (Z0 + Z1) | normal (Z0) | normal(Z1) | normal(ANF) | normal (Z0 + Z1) |
| 29.61 | 31.17 | 39.21 | 60.79 | 19.65 | 49.36 | 30.98 | 69.02 |
| 34.17 | 37.88 | 27.94 | 72.06 | 21.72 | 52.73 | 25.55 | 74.45 |
| 38.25 | 39.21 | 22.54 | 77.46 | 27.3 | 48.51 | 24.19 | 75.81 |
| 43.77 | 34.4 | 21.83 | 78.17 | 28.77 | 58.14 | 13.08 | 86.92 |
| 44.17 | 38.99 | 16.85 | 83.15 | 29.26 | 60.83 | 9.91 | 90.09 |
| 44.99 | 47.57 | 7.45 | 92.55 | 30.05 | 66.02 | 3.94 | 96.06 |
| 45.92 | 47.51 | 6.57 | 93.43 | 36.42 | 62.79 | 0.79 | 99.21 |
| 51.73 | 41.7 | 6.57 | 93.43 | 38.01 | 61.57 | 0.42 | 99.58 |

Table 2 the rates of the results about learning by AI

4. Discussion and conclusion

As shown in the table 1 and table 2, When we increase training sets, **ANF(Action Not Found)** is decreased and **Z0** and **Z1** is increased. Speaking of the degrees of learning by AI, It could learn to find from playing data well. Basically, When the training sets is sixteen and the difficulty of it is more than the difficulty of playing data, **Z1** is more than **Z0**. It can be observed that after 16 matches the AI can find a matching game situation in 100% of cases. Among them, 59.4% were found on the most-precise Z1 level, which we consider a good achievement.

In conclusion, we demonstrated that the accuracy of the learning level by AI was higher because the elements what AI could learn is increased when we increase training sets and we adjust the difficulty of opponent to be almost equal to.

5. References

- [1] M. Mozgovoy, I. Umarov. Behavior Capture with Acting Graph: a Knowledgebase for a Game AI System. Lecture Notes in Computer Science, 2011, vol. 7108, pp. 68-77.
- [2] Universal Fighting Engine (UFE). <http://www.ufe3d.com>