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A Fighting Game AI with Evolutionary Strategy and Imitation Learning in Opportunity Maximization and Sensible Maneuvering Tactic

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***Abstract* – In this paper, we present a novel approach that generates unique sets of combo based on what we assumed as human-like intelligence which comprised of a simulation of simple cognitive process of human thinking in maximizing an opportunity. Such mechanism involves two sub-processes: first is where a fast and incomplete optimization takes place, we applied evolutionary strategy to optimize the selection and formation of combo for maximizing a situation's outcome whereas secondly, for maneuvers, imitation learning is employed. In common game terms, the set of actions is referred to as a combo. In fighting games, human players usually prefer to play with other human players, the NPC controllers used in fighting games often utilize pre-scripted artificial intelligence (AI). Therefore, this work is aimed at creating an AI that is human-like, dynamic and fun to play with, instead of being simply plain strong. Evaluations are performed via a survey, and results are studied and discussed.**

Keywords—fighting game, artificial intelligence, human-like, evolutionary strategy

I. INTRODUCTION

In a typical fighting game, a player controls his or her character that represents them until a predetermined level of energy is spent [1]. It is basically a simulation of hand-to-hand combat, where fights are carried out in a manner similar to boxing matches with a time limit. In short, in each round there will be two participants with a standard setting of three rounds per match. The participant who has lowered the energy of the opponent to zero is the winner of the round. [2]

II. HUMAN-LIKE NPCS

In fighting games, human players play against one or more players by controlling their respective character in the game. However, if the game is being played by only one human-player, the AI will control the opponent character(s). In this case, human players generally play single player mode because there is no other human players to play with. Usually, if they can, they would prefer to play against other human players.

One of the reasons is that simply because the standard fighting game AI cannot offer an interesting game experience. In most cases, pre-scripted AI always projects the same predictable behavior. While, on the other hand, human players can learn and adapt their playing style during a gameplay, have a human's reaction speed, and significantly affected by their emotions. Through trial and error, they can also learn how one move can be more effective than other moves for a given situation and select the best move for that situation or similar situations. Therefore, for an AI controller, the most important point is about how to play "like a human" and make the game process more interesting. [2]

III. PLAYING WITH COMBOS

In fighting games, players control the characters to use actions to defeat opponents and win the game. Different actions have different basic elements, such as damage, speed, delay and etc. Human players often learn these as they play, and remember these as a mix of knowledge of both characteristic and experience. Through different game experience and way of thinking, every human player eventually have their own unique strategies and habit. One of which is the "combo", short for combination of attacks. Combos are created through many countless ways by putting together several moves that are able to connect from one to another within a limited time, giving an illusion of continuous attacks that interlinks and offer much more interactivity and effectiveness.

IV. PROPOSED METHOD

For the AI controller, we propose multiple control units: action, movement, and judgment to simulate a simple cognitive process that represents the way how a human thinks. Action and movement units are the intelligent motor units which suggest the judgment an optimal set of actions and sequences of movements. Typically for a normal player, whenever he or she faces a new game, the player is likely to only have: the common perception of this type of game, such as the way to input command and standard game rules; some human limitations, for instance, the capacity for processing information or reaction delay; biased characteristic of human or favorites, such as either distance attacks or melee attacks.

Initially, in action unit, we used (1, λ)-ES to suggest a list of offensive combos as a base where the flow can be seen in Fig. 2 and its fitness function is defined as

$$f_{combo} = \sum_{i=1}^{C_{max}} \sum_{j \in F} \frac{E_{ij} - E_{j_{min}}}{E_{j_{max}} - E_{j_{min}}} W_f, \quad (1)$$

where C_{max} defines the max length of combo, E as element of value of the skill, j as elements to be used to evaluate the combo, F as all elements of the skill that can be selected, and W as weight of the elements.

Given the main purpose of evolutionary strategy (ES) is to provide optimization, this is to attempt to simulate a part of human's ability to optimize the combination of actions to achieve better maneuvers and characteristic. To simulate the human limitation of short term memory capacity, λ = 4 is suggested for the ES. Further evaluation details are discussed in Section V.

Movement unit mainly uses to change the position of the characters and find better chance to execute combos. In movement unit, certain sequences of movement that are collected from human opponents are reproduced to imitate the fluid movement of human players. In this case, all the sequences of movement are collected by the following rules: Starting from the next frame of an action, and end before next action; Take out the last 3 directional inputs before next action is executed. Length of movement must be longer than 15 frames. In every round of the game, the AI collects about 20 sequences of movement on average to be used in the next game.

Within judgment unit, the AI evaluates the combo list and keeps it updated during the game based on the success rate collected from game data. Combo ratings, R_{combo} are the result of calculation of both successes, S_{combo} and weights using the formula in Fig. 1.

$$S'_{combo} = \begin{cases} S+2 & Clean\ hit(twice\ or\ more) \\ S+1 & Hit\ (once) \\ S & Be\ guarded \\ S-1 & Miss \\ S-2 & Be\ damaged \end{cases}$$

$$R_{combo} = f_{combo} * W_f + S_{combo} * W_s$$

Fig. 1. Success rating and Combo Rating

The resultant combo rating are then used to determine the combo's overall goodness and describe a certain level of bias due to personalized weights and game experiences. In a populated combo list, roulette wheel is used to select which combo to be executed. Naturally, higher combo rating indicates higher probability of being chosen. However, if there are no combos that are suitable for a given situation, the judgment unit will then execute a sequence of movement that is suggested by movement unit and wait for a better chance.

V. EVALUATIONS

Based on the research of "magical number 4 in short-term memory" by [3], we choose to the following parameters: λ= 4, $Cmax$ = 4 and length of combo list = 4 to describe the capacity for processing information of human. In our testing case, we consider game experiences to have greater impact than biased characteristics. Therefore we define the following weights as W_f = 0.3, and W_s = 0.7. All fighting simulations are performed on FightingICE platform developed by our laboratory.

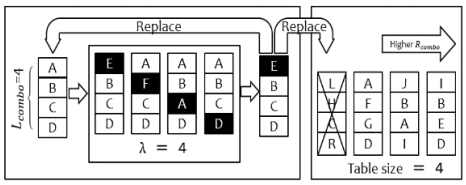

Fig. 2. The Flow of Evolutionary Strategy

The evaluation of the proposed AI controller is done via a questionnaire survey test where: all survey participants are asked to view 6 games played by 4 AIs and 2 of human players as P1 versus a random AI as P2, and then presented with the questionnaire "In this video clip, do you think the player, who controls the P1, is a human player?" together with 5 choices of answer which are "Yes", "Probably yes", "Unsure", "Probably no", and "No".

These AI sample are: A – Random AI; B – Mizuno AI; C – Test AI (the proposed AI); D – T (Champion of 2013 FTG competition); E – Human player with over 200 hour of fighting game experience; F – Human player with less than 10 hour of fighting game experience.

	Yes	Prob yes	Unsure	Prob no	No
A	2	4	9	17	18
B	7	13	11	13	4
C	5	23	6	8	3
D	7	5	11	12	10
E	19	14	7	5	1
F	12	16	14	6	1

Fig. 3. The result of survey

According the result of survey we can see more than 72% (39 in 54, rank 1) and 54% (31 in 57 rank 3) of participants can find out 2 human players from samples (with rating "yes" or "probably yes"). And more than 55% (30 in 53, rank 2) gave Test AI a high human-like rating (with rating yes or probably yes), further than sample B – 39 %(22 in 56, rank 4) and the other AIs.

VI. CONCLUSION

This paper proposed an AI controller for fighting game "Fighting ICE" that can create combos for opportunity maximization, and generate different combo through the simulation of the human player's way of thinking.

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