Developing emotional AI of fighting game with Gamygdala

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Abstract

The fighting game AI advances day by day and can now be played on a level of professional human player. However, these AIs are monotonous and nothing to wide range of the enjoyment of fighting game. Every character in the fighting game moves in the same motion, and it is felt that the entertainingness of the fighting game is impaired. This may be due to operating the character at the same difficulty level whole the game and utilizing pre-scripted AIs. To solve this problem, I introduce emotions into game AI and implement traits of human-like behavior, such as affective (emotional) decision-making. In this paper, I show how the task can be achieved. I use Gamygdala, an emotional appraisal engine, to evaluate emotional states of the computer-controlled opponent in UFE, fighting game engine, and translate emotions into actions with psychological approach.

1 Introduction

Fighting games simulate a one-to-one combat encounter of the player with a human or AI-controlled opponent. So, the AI-controlled opponents of state-of-the-art fighting games have developed to a level where they can compete with game professionals [1]. But, game difficulty is not always directly resulted from player enjoyment [2]. Furthermore, most fighting games utilize pre-scripted AIs. It means that, for similar situations, such an AI always behaves in the same manner. This will quickly get the player bored with the game. Thus, the challenge now is to create fun artificial opponents, providing enjoyable player experience.

It is generally presumed that people enjoy playing against other people because they behave in according to their current state (emotions, game playing experience, etc.) rather than mechanical. Therefore, a fun AI opponent has to have certain human-like characteristics, such as adaptability to the opponent's actions and recognizable play styles. The purpose of this study is to implement human-like behavior, emotional decision making, for fighting game AI. We believe that If the NPCs can express emotion move during battle, the game will be more fun for human players. In practice, this means that some actions of NPCs will be triggered by internal emotional changes assessed by the emotional engine.

2 Emotion appraisal with Gamygdala

I use Gamygdala as a means of emotional appraising actions of opponent character in the game. Emotion evaluation events can be generated for opponent action in the game, and can be evaluated by Gamygdala.

To apprise emotion, Gamygdala is needed to set up goals and beliefs of the characters. Goals are states of the game that an NPC wants achieved or states that an NPC wants maintained and has a utility value of desire for that goal. Its value ranges from -1 to 1 and is proportional to the degree of desirability of the character. Beliefs are annotated events. This event affects the emotional state of the characters by moving the character closer to or away from their goals. For example, if this event occurrence is desirable for an agent's goal, the agent will be pleased. Conversely, agents who do not like occurring the event will feel angry. Belief has the values of likelihood that indicates the probability that the event occurred, the agent that caused it, the goal that affected it. In addition, it is possible to implement emotional decline by notifying the elapsed time of the game to Gamygdala.

Gamygdala is designed for use in complex multi-agent environments that can indirectly connect the goals of different agents. Agents are friendly, hostile,
or neutral with each other, and information passed between agents (such as rumors) may also be uncertain. Considering that the adaptation of Gamygdala for fighting game is very simple because fighting games are one-on-one matches. It means that there are only two opposing agents, each with opposite goals, no event with uncertainty. When needed, Gamygdala appraises each agent's emotions and return the current emotional state and intensity. Emotions in Gamygdala are implemented 16 of the 24 emotions defined by OCC model [3].

3 Goals and Beliefs of UFE agents

There are six goals in implementation of my system as described below and they are all associated with NPC:

1. Win by KO (utility = 1):
The agent wins when the opponent's health level reaches zero.

2. Lose by KO (utility = -1):
The agent loses when the agent's health level reaches zero.

3. Win by Points (utility = 0.7):
The agent wins by points when the round time is over, and the agent's health level is higher than the opponent's health level.

4. Lose by Points (utility = -1):
The agent loses by points when the round time is over, and the agent's health level is lower than the opponent's health level.

5. Keep High Morale (utility = 0.6):
The agent's morale is affected by several ad-hoc events. This goal is applied when the events works positively for the agent.

6. Keep Low Morale (utility = -0.6):
This negative goal is handled analogously to the previous one. This goal is applied when the events works negatively for agents.

Each of these goals is related. For example, when the agent hits the opponent, then its health level is reduced, it means increasing its own chances of winning by KO and time over due to the agent's health level is higher than the opponent's health level. Also, these goals are distinct. For example, when opponent's health level is reduced, the chances of losing are not changed because they depend on the value of the own health level rather than that of the opponent. In our system, agents are set to prefer knockout wining to winning by points. but, Winning by points is a legitimate goal. losing by points is as undesirable as losing by a knockout. The goals of "Keep Morale" were introduced to address certain scenarios where people generally feel uplifted or uncomfortable (unsporting behavior like overly evasive tactics can be an example of the latter case). I do not assign any goals to the human-controlled character because it has the same events and are mostly opposite to the goals listed above.

The emotional state of a given NPC is affected by the beliefs, as listed in Table 1. The emotional decay event ("cooling down") is generated once per second.

Table 1: **Belief of the AI Agent**

Belief name (causal agent) Event trigger	**Goals affected (+/–)**
Caused damage (NPC): Occurs when NPC hits the opponent, reducing its health level.	Win by KO (+) Win by Points (+) Lose by Points (–)
Received damage (Opponent): Occurs when the opponent hits NPC, reducing its health level.	Lose by KO (+) Lose by Points (+) Win by Points (–)
Spent time winning (Empty): Occurs every second as long as NPC's health level is higher than the opponent's health level.	Win by Points (+) Lose by Points (–)
Spent time losing (Empty): Occurs every second as long as NPC's health level is lower than the opponent's health level.	Lose by Points (+) Win by Points (–)
About to win by points (NPC): Occurs when time is running out while the agent has more health than the opponent.	High Morale (+) Low Morale (–)
About to win by KO (NPC): Occurs when the opponent's health level reaches zero	High Morale (+) Low Morale (–)
About to lose by points (Opponent): Occurs when time is running out while the opponent has more health than the agent.	Low Morale (+) High Morale (–)
About to lose by KO (Opponent): Occurs when the agent's health level reaches zero	Low Morale (+) High Morale (–)
Failed to attack 5 times (Opponent): Five consecutive attacking moves of the agent were unsuccessful.	Low Morale (+) High Morale (–)
Made 3 successful attacks (NPC): Three consecutive attacking moves of the agent were successful.	High Morale (+) Low Morale (–)

Opponent is very resilient (Opponent): The agent received damage five times consecutively without being able to cause any damage.	Low Morale (+) High Morale (–)
Opponent is evasive (Opponent): The agent failed to cause any damage for 10 seconds while receiving no damage.	Low Morale (+) High Morale (–)

Belief congruence values block or promote a particular goal on a scale [-1, + 1] which a particular belief is. Currently we use the following rules:

1. Caused damage/Win by KO:

$$c[congruence] = 1 - \frac{OppHealth}{MaxHealth}$$

2. Received damage/Lose by KO:

$$c = 1 - \frac{NpcHealth}{MaxHealth}$$

3. Any belief facilitating or blocking Win by Points:

$$c = \frac{RoundTime \times (NpcHealth - OppHealth)}{MaxRoundTime \times MaxHealth}$$

4. Any belief facilitating or blocking Lose by Points:

$$c = \frac{RoundTime \times (OppHealth - NpcHealth)}{MaxRoundTime \times MaxHealth}$$

5. About to win by KO or by points:

$$c\ (KeepHighMorale) = 0.7$$
$$c\ (KeepLowMorale) = -0.7$$

6. About to lose by KO or by points:

$$c\ (KeepHighMorale) = -0.7$$
$$c\ (KeepLowMorale) = 0.7$$

7. Made 3 successful attacks (incremental event):

$$c\ (KeepHighMorale) = 0.2$$
$$c\ (KeepLowMorale) = -0.2$$

8. Failed to attack 5 times, opponent is evasive, opponent is resilient (incremental events):

$$c\ (KeepHighMorale) = -0.2$$
$$c\ (KeepLowMorale) = 0.2$$

Congruence values in incremental events are treated as relative contributions towards or against the goal.

4 Translating emotions into action

Instead of own fighting game AI, I make NPC humanlike behavior by reflecting the emotional response of NPC to the behavior parameters of Fuzzy AI - a flexible custom fighting AI system that can be fine-tuned to obtain desired character behavior in UFE, in real time. The parameters used in this study are as Table2.

Table 2: **Parameters of Fuzzy AI**

Type	Name Description
enum	**Behavior style**: Five grades from Very Defensive (1) to Very Aggressive (5)
float	**Time Between Decisions**: The minimum time taken to formulate a decision.
float	**Time Between Actions**: Time between executing each decision.
float	**Aggressiveness**: Controls the preference of attack moves. (ex, Defensive, Aggressive...)
float	**Rule Compliance**: make the AI be more systematic or more random.
float	**Combo Efficiency**: Controls how efficient a combo has to be to proceed with it.
bool	**Attempt inputs when down**: Try reactions even when the AI player is down.
bool	**Attempt inputs when blocking**: Try executing moves when the AI player is blocking.
bool	**Attempt inputs when stunned**: Try executing moves when the AI player is stunned.
bool	**Attack when enemy is down**: Keep attacking when the opponent is down.

bool	**Attack while enemy is blocking**: Keep attacking when the opponent is blocking.

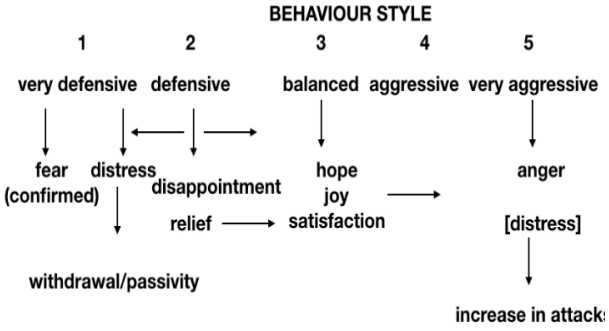
Numerous studies confirm the effect on decision making and judgement [e.g. 4-8]. Positive emotions tend to increase the deliberateness. It means to process large amounts of information at high speed and risk avoided, while negative emotions promote to make simpler decisions, increased risk and polarized judgment [9]. Generally, positive affect is related to faster thinking and negative affect with the opposite [5]. Isen [10] argues that positive emotions facilitate to make decisions more quickly and improve efficiency in sorting out information, resulting in more efficient and more thorough decision making. As important motivators, emotions clearly influence action [11–13]. In fighting game, I consider only those effects that are related to the overall goal of defeating the hated opponent, the rules of translating emotion into action are limited here to 9 emotions, hope, fear, fearsConfirmed, joy, distress, satisfaction, disappointment, relief, and anger. For further discussion of the reactions triggered by these particular emotions, see, e.g., [14–22]. The rules for changes in fuzzy AI parameters, as triggered by each affect are listed in Table 3.

Table 3: **Emotions affecting Fuzzy AI Parameters**

Parameters	**Rules**
Behavior style	See figure1
Time between decisions	1, higher hope, satisfaction, relief => increase time between decisions, decrease aggressiveness 2, higher fear, fearsConfirmed, joy => decrease time between decisions, decrease aggressiveness 3, higher distress, disappointment => increase time between decisions, decrease or increase aggressiveness 4, higher anger => decrease time between decisions, increase aggressiveness
Time between actions	1, higher fear, hope =>delay action 2, higher disappointment, anger, joy => execute action immediately, (instant gratification, lowered expectation) or delay action (deferred gratification, positive outcome) 3, higher satisfaction => decrease time to action execution 4, higher relief => increase execution time
Aggressive-ness	1, higher hope, anger, distress => increase frequency of attack moves 2, higher fear/fearsConfirmed, disappointment, relief => increase frequency of basic moves
Rule compliance	1, higher hope, satisfaction, relief => increase predictability 2, higher fear, joy, disappointment, anger => increase randomness
Combo efficiency	1, higher anger, fearsConfirmed, distress => decrease combo efficiency 2, higher joy, satisfaction, hope => increase combo efficiency
Attempt inputs when down	distress, fearsConfirmed, disappointment => reduce aggressiveness, increase basic moves (idle, hide); increase time between decisions and actions
Attempt inputs when blocking	fear, disappointment => increase counterattack moves and increase randomness; success results in satisfaction, failure in anger => in both cases increase attack moves, with anger => increase aggressiveness
Attempt inputs when stunned	fearsConfirmed, distress, relief (not dead) => increase defensiveness and basic moves (idle, hide); or (when triggering anger) => increase aggressiveness/attack moves, and randomness
Attack when enemy down	satisfaction, joy, hope (to perform the mortal hit) => increase attack moves, decrease randomness, increase combo efficiency

Attack while enemy is blocking	1, anger, disappointment => increase aggressiveness, increase attack moves, increase randomness 2, hope => increase attack moves and combo efficiency, and decrease randomness

Figure 1: Indicating style changes with the emotions obtained. The horizontal arrows indicate an increase or decrease in aggressiveness



5 Conclusion

In this paper, I show how to introduce emotional values to AI of fighting games and how to re-design AI that is more enjoyable for users than existing AI. The emotional state of a computer-controlled character in match is measured with Gamygdala. This approach means to change the rules of an existing AI system, such as Fuzzy AI of Universal Game Engine, with emotions: emotional states of opponent character can be used to fine-tune the settings of an existing AI.

One major aspect of this work is how to convert emotions into actions. First, it is necessary to understand how different types of emotions affect real human behavior. My AI rules were designed based on the results of the psychology research. However, it is not guaranteed that this AI system embodies human-like movements of computer-controlled opponent and more importantly contributes to the enjoyment of users. Thus, extensive testing and fine-tuning of the system are my next goals.

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