Better NPC Combat Responses Through Search Trees

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Abstract

Games are perhaps one of the first fields in which AI was used. NPCs—Non-Player Characters—were one of the first types of "agent" in AI. Through the years, AAA (Triple-A) gaming companies have developed different algorithms and methods for their NPCs so that they will feel more *alive*—most of which are proprietary[1]. This paper aims to provide methods of equipping NPCs with the right artificial intelligence so that they will feel more proficient and competent in real-time RPG[1] combat systems.

Introduction

Games have a long history in the co-evolution of AI and machine learning. The construction of synthetic worlds in games has served as a useful test-bed for AI algorithms[4]. Over the course of years, many researches has been done on game AI, the most recent of which being OpenAI's *Dota 2* AI[4, 5].

These agents, however, provide a very limited experience and extensive training, testing and resources are required for them to perform well. OpenAI states that

> "[The agent] played over 180 years' worth of games every day ... and performs around 20,000 moves per game, meaning a long horizon to gather fitness information about an AI instance."[4]

In turn, it was able to outperform the dominating human champions of Dota 2's E-Sports stage[4].

This paper, however, does not aim for such mighty goals but instead, focuses on the development of methods to implement intelligent agents on regular limited-resource computer systems in a real-time manner. This approach also allows the agent's difficulty to be adjusted accordingly to the human player's skill levels—preventing the game from becoming too hard to play for beginner, or even experienced, players.

[1] Role Playing Game

The idea for a more realistic game combat is inspired by best-selling games such as *Dark Souls*[3] and *The Witcher*[2]; these games, while providing a great experience, use a predefined set of instructions for the actions of their NPCs in combat—making mastering the game combat extremely easy after a while, thereby lowering the challenge.

The Environment

For the sake of simplicity, many elements of a typical RPG game are going to be eliminated; most notably, the *environment itself*. Since the goal is to provide a searching algorithm for better response in *combat*, environmental elements such as hill steeps, pitfalls, other creatures, etc. will only act as distractions and simulating them will not be of necessity.

The simulation environment is a simple, flat-surfaced ground. The only other entity in this environment except our agent will be the human player. As such, our environment will have the following properties:

1. Fully observable
2. Competitive multiagent
3. Deterministic
4. Episodic
5. Semi-dynamic
6. Continuous
7. Known

Each player will have a predefined set of moves, which again, for simplicity, will be extremely limited; namely, "attack", "dodge" and "block". Further actions might be added in the future for the sake of accuracy. The complete description of the game mechanics will be provided in a later section.

Knowledge Base

The agent will be holding a *limited* knowledge-base of the actions performed by itself and the player at all times. The knowledge-base will be represented as a table with the following structure:

Action	Actor	Time	NPC	Player	Score
{Atk,Ddg,Blk}	{1,0}	ms	+/- x	+/- y	z

Action The type of action performed by the *Actor*; can be either *Attack*, *Dodge* or *Block*.

Actor Who performed the *Action*—1 stands for the NPC and 0 for Player.

Time The total time from the moment of *Action* initiation up to assignment of a *Score*.

NPC The result of *Action* on the NPC—the NPC will lose score if damage is inflicted upon it and gain score upon inflicting damage.

Player The result of *Action* on the Player—the Player will lose score if damage is inflicted upon it and gain score upon inflicting damage.

Score The total score gained from the *Action*. The score is determined based on all the previous factors.

The type of *Action* directly determines the *Time* it takes to perform it. It also affects the base *Score* for the agent: Attacking is highly valued and yields a high positive score, dodging yields no score, and blocking, although faster than dodging, yields some amount of negative score. No more than a few hundred rows may be held inside the KB at any given point of time.

Mechanics

The basic goal of each agent in the simulation is to come out victorious from the arena; as such, *Health Points*—or the more widely used term *HP*—may seem like a good indicator for our agent's performance. However, victory alone is not enough to motivate the agent to play *competitively*. Imagine a scenario in which the agent would constantly run away from the player until the player gets bored and drops the game; then would be a good time to attack—with zero risk involved. Therefore, we need to introduce a notion of *time*; not only will the agent gain score upon damaging and lose score upon receiving damage, its performance will also be measured in terms of the time it takes to achieve a certain result.

Algorithms

The goal of this study is to use hybrid approaches toward learning; as such, a variety of methods and algorithms will be used to discover the most efficient method of decision-making. Some of the methods which I plan on investigating include a combination of Logic, Minimax, and Local Search algorithms.

Challenges

This study poses a number of different challenges. The first of which is actually simulating the battleground using text. Some the challenges in this field include:

- Timing user response times

- Defining methods to input actions
- Defining methods of communicating the result

Other challenges which are present in any AI research include:

- Defining the search state
- Defining the algorithm
- Memory limits: How much data on the user should be gathered?
- Speed: Real-time search on a constantly changing knowledge base
- Sub-optimality: We do not wish for perfect results

References

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