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***Abstract*—**

***Index Terms*—game-playing agent, artificial intelligence, EvoMan, genetic algorithm, reinforcement learning, q-learning, neuroevolution, particle swarm optimization, proximal policy optimization, ppo**

I. Introduction

II. Problem Description

A. Environment

EvoMan [?], [?] is a framework for testing competitive game-playing agents. This framework is inspired by Mega Man II [?], the game created by Capcom. In the original game, the player would have to beat 8 opponents and acquire their weapons as they are defeated. The additional difficulty of EvoMan comes from the fact the player has to defeat all the opponents using only the starting weapon. The framework is freely available[1] and it is currently compatible with Python 3.6 and 3.7. There is also an extensive documentation available[2]. The agent will collect information about the environment through 20 sensors (Fig 1):

- 16 correspond to horizontal and vertical distances to a maximum of 8 different opponent projectiles.
- 2 correspond to the horizontal and vertical distance to the enemy.
- 2 describe the directions the player and the enemy is facing

The actions which the agent may take are:

- walk left
- walk right
- jump
- shoot
- release of the jump

The lives of the player and the enemy start at 100. Everytime one of them gets hit, their life deplenishes. Whoever's life reaches 0 loses the game.

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[1]https://github.com/karinemiras/evoman_framework

[2]https://github.com/karinemiras/evoman_framework/blob/master/evoman1.0-doc.pdf

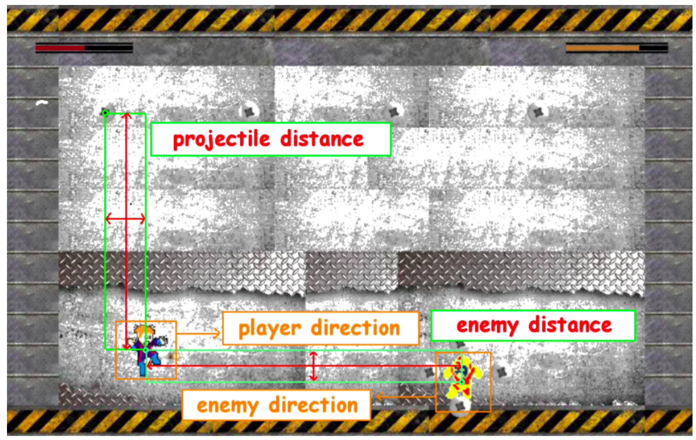

Fig. 1. Sensors available for the player.

B. Problem

The specific problem we are trying to solve is to train an agent on only four of the eight enemies with the purpose of maximizing the score gain evaluated against all opponents. Since the enemies are very different we should aim for the agent to find generally good strategies like aiming towards the opponent and avoiding projectiles. The gain of an agent after a game is computed as:

$$gain = 100.01 + player\_energy - enemy\_energy$$

The final score metric of an agent is the harmonic mean of the gains against all enemies.

C. Result Upper Bound

(todo: cite https://arxiv.org/pdf/1912.10445.pdf) The author of the EvoMan framework trained multiple specialized agents against all opponents. The highest final gain, 185.67, was obtained with the NEAT(todo: cite) algorithm.

III. Approach

A. Q-Learning

B. Neuroevolution with Genetic Algorithms

C. Neuroevolution with Particle Swarm Optimization

D. Proximal Policy Optimization

E. Neuroevolution with Particle Swarm Optimization Bootstrapping and Proximal Policy Optimization

IV. Experimental Investigation

cautare 2d - algoritm si puncte de start. rezultate partiale si deciziile luate dupa fiecare.

V. Results

informatii despre laptop (pentru ca trebuie mentionat timpul de rulare). obs: pentru 1, 6, 7 am obtinut gain mai mare decat orice algoritm specializat (din upper bound)

TABLE I
Table Type Styles

Table Head	**Table Column Head**		
	Table column subhead	***Subhead***	***Subhead***
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[a]Sample of a Table footnote.

Fig. 2. Example of a figure caption.

References

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