Autonomous Driving Agents Trained by an Algorithm Based on NeuroEvolution of Augmenting Topologies (Neat) Using a New Logarithmic Fixed-Point Number System Optimized for Microcontrollers

Hyzyk, Krzesimir (School: European School Luxembourg 1)

In recent years, multi-agent systems have become increasingly more prominent in robotics, factories, and space exploration. This brought up a new class of control theory problems usually very difficult to solve. To tackle such a problem, I have built a dedicated physical environment: 6x6 foot perimeter, 16 autonomous agents (autonomous cars with an innovative automatic gearbox), 16 Raspberry Pi Pico WH microcontrollers, 361 RFID tags, 16 RFID readers, 4 Wi-Fi antennas, one 2 Gb network switch, and a launchpad as a user interface. In this environment, each agent's task is to drive to a randomly chosen location, whilst minimizing the number of collisions. To control and train the agents, I have adapted the NeuroEvolution of Augmenting Topologies (NEAT) algorithm, which is a versatile unsupervised machine learning technique, stemming from both neural networks and genetic algorithms. The agents were first trained virtually, in a virtual clone of the physical environment, making it possible for the agents to learn the challenges of the task before facing the physical environment, and then trained physically, in the perimeter. Yet, such an algorithm produces large models with thousands of neurons, that are too costly to evaluate on microcontrollers lacking floating-point hardware. Therefore, I have developed a new logarithmic fixed-point number system, allowing for both a high throughput of computations, and good accuracy. My project has therefore shown how to solve a difficult multi-agent control problem with cost-effective hardware and adequate training methods. This could be applied to other types of problems, such as drone swarms or recovery missions with flexible vehicles.

Awards Won:

Third Award of $1,000