

Linking Learning Fundamental Reinforcement Learning Concepts with Being Physically Active

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ABSTRACT

In this paper, we define a learning activity for an elementary physical education classroom that simultaneously engages students in physical activity while introducing students to basic principles of reinforcement learning. Reinforcement learning is a sub-domain of machine learning in which an independent agent (in our activity, a student) takes some action or series of actions and receives a reward for the chosen action(s). While reinforcement learning intuitively maps to many activities in our daily lives, our learning activity involves a spy game. Students create sequences of spy moves that generate rewards based on their component moves and the orders in which they are performed. Students then iteratively expand their spy moves in an attempt to receive the maximum reward. The construction of the game will demonstrate that the rewards, while deterministic, do not always follow a greedy pattern, introducing students to basic algorithmic principles. Such an approach that combines physical activity with reinforcement learning connects artificial intelligence education within the broader scope of computing and students' everyday lives.

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1 REINFORCEMENT LEARNING ACTIVITY

Recent efforts have explored computational thinking based learning activities for children as young as elementary school [1]. In contrast to more traditionally-structured high school classrooms, elementary classroom activities have shorter duration and often entail learning through physical activity [2]. We build on previous efforts to join in-school STEM education with physical activity and translate them into the computational thinking context through an activity that introduces reinforcement learning to elementary school students. While hands-on projects and unplugged activities related to Artificial Intelligence (AI) and machine learning (ML) exist for elementary school classrooms [3], existing work is limited and preliminary, leaving the creation of AI and ML elementary educational content an important area for growth.

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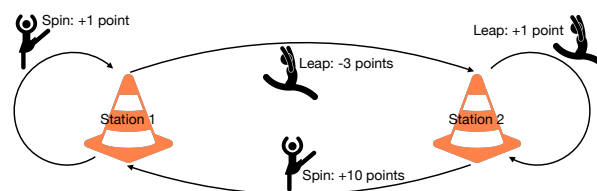


Figure 1: Sample finite state machine with two states that we will use in the classroom.

We design an activity for a physical education class that teaches elementary school students basic concepts related to reinforcement learning while encouraging them to be physically active. Figure 1 shows a simple example; the activity easily expands to more states and actions. Students act as spy “agents” whose goal is to score the most points by enacting a series of spy moves. The teacher begins the game by instructing the students to gather around a cone labeled “Station 1”. The teacher then asks each student to choose one of a set of available actions (e.g., Kick in the example in Figure 1). An action may cause a student to move to a new station, and each selected action from a station rewards the student with a number of points associated with that action. Once the students perform their actions, the teacher tells them where to move and how many points they receive. After a fixed number of moves, the game concludes and the students report their point totals.

After the activity, the teacher can evaluate what students have learned by asking them a series of assessment questions and asking them to reflect on how these concepts relate to their everyday lives. We align the design and implementation of our activity with standards present in the K-12 CS Framework [4], AI4K12 [5], and ISTE [6]. We anticipate students will learn key concepts including reinforcement learning, greedy algorithms, and computational thinking basics while they are also physically active.

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