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A Reading of  
Peter Stone and Manuela Veloso's  
Towards Collaborative and Adversarial Learning

Less ambitious than what one might expect from the title of this paper, "Towards Collaborative and Adversarial Learning" deals with training a simulated soccer player to successfully intercept a moving ball. This activity is portrayed as a multi-agent learning task since, in the context of robotic soccer, the ability to intercept a moving ball is often tied to receiving a pass from another player, and is therefore part of an overarching collaborative effort.

The authors present a neural network (NN) machine learning approach to the acquisition of this low-level behavior, which is performed under the umbrella of the RoboCup Simulation Server. Several factors are varied throughout the experiment: ball speed, the trajectory of the ball, goal location and the player's action quadrant.

In the simplest scenario of fixed parameters, the paper shows high success rates using learning based on a 3-input hidden-layer NN. An additional input node is then needed to be added to account for varying ball speed, and further adjustments to the learning approach that will not be covered here were also tested and compared.

On the face of it, this paper has not much to do with collaborative behavior, especially since it's dealing with such a "simple" task. The authors do, however, put the learned low-level behavior in the context of team play and collaboration in a final section of the report. In that section, Stone and Veloso hint to what they would later describe as a "layered learning" approach. This approach uses building blocks from lower-level learned behaviors to serve in the formation of higher-level behaviors.

In this particular example, the passer can make use of the same neural network "building block" that it learned from intercepting passes in making the decision when and how to pass the ball to a similarly designed agent.

It might be interesting to note that there is a hidden assumption of "sameness" inherent to this layered learning method. This could be related to the inherent assumption of "sameness" that is part of our Theory of Mind. Of course, this is a much simplified version of ToM.

In later work, Stone and Veloso did indeed incorporate the NN of the ball-interception capability into the higher-level collaborative capability of passing the ball to another player, with much experimental success.