Maastricht University

Faculty of Humanities and Sciences

Project title: Real-Time Monte-Carlo Search for Physics-Based Simulation Games: Applications to Space, Advanced Manufacturing and Transport.

Project leader: Dr. Mark H.M. Winands

Function: Associate Professor / Director of Studies

Collaborators: Prof. Ralf Peeters

Proposal (250 words):

Introduction: Physics-Based Simulation Games (PBSGs) such as Angry Birds or Computational Pool have become increasingly popular in recent years. In these games, physics simulators have complete information about and control over all the physical properties of all objects in the game world. As such, each move and its consequences can be exactly simulated and displayed, which makes the physical behaviour of the game appear quite realistic. The challenge for an agent in these games is how to handle the large number of possible moves in real-time. Recently, a reasoning technique called Monte-Carlo Tree Search (MCTS), has led to increased level of play in a wide range of abstract games (such as Go).

Hypothesis and Objectives: The aim of the proposal is to develop effective methods within this MCTS framework for PBSGs. The two research questions are:

1: "How to develop abstraction methods such that MCTS can efficiently explore a continuous state-action space?"

2: "How to develop methods such that MCTS can perform effectively in real-time?"

Setting and Methods: Agents have to be developed that are able to compete in PBSGs where there is an active research community and tournaments. To have realistic results, the developed methods are evaluated in a disparate set of domains. To mitigate the risk of immediately combining methods for dealing with abstraction and real-time, the initial focus is on PBSGs that do not include both aspects.

Impact: The impact goes beyond games and will be an essential feature of agents that interact with the physical world such as space, advanced manufacturing and transport applications.

Requirements candidate: Highly motivated student with good English communication skills and proactive and resolute attitude.

Keywords: ICT, Space, Advanced Manufacturing, Transport, Artificial Intelligence, Monte-Carlo Tree Search, Physics-Based Simulation Games, Real-Time

Top 5 selected publications:

1. Chaslot, G.M.J-B., Winands, M.H.M., Herik, H.J. van den, Uiterwijk, J.W.H.M., and Bouzy, B. (2008). Progressive Strategies for Monte-Carlo Tree Search. New Mathematics and Natural Computation, Vol. 4, No. 3, pp. 343-357. ©World Scientific Publishing Company. Received the 2008 ChessBase Best-Publication Award. **Citation score: 203**

2. Chaslot, G.M.J-B., Winands, M.H.M., and Herik, H.J. van den (2008). Parallel Monte-Carlo Tree Search. In Computers and Games (CG 2008), Vol. 5131 of Lecture Notes in Computer Science (LNCS), pp. 60-71. © Springer, Berlin Heidelberg. **Citation score: 174**

3. Winands, M.H.M., Björnsson, Y., and Saito, J-T. (2008). Monte-Carlo Tree Search Solver. In Computers and Games (CG 2008), Vol. 5131 of Lecture Notes in Computer Science, pp. 25-36. © Springer, Berlin Heidelberg. **Citation score: 82**

4. Schadd, M.P.D., Winands, M.H.M., Chaslot, G.M.J-B, Herik, H.J. van den, and Uiterwijk, J.W.H.M. (2008). Single-Player Monte-Carlo Tree Search. In Computers and Games (CG 2008), Vol. 5131 of Lecture Notes in Computer Science (LNCS), pp. 1-12. Springer, Berlin Heidelberg. **Citation score: 62**

5. Winands, M.H.M., Björnsson, Y., and Saito, J-T. (2010). Monte Carlo Tree Search in Lines of Action. IEEE Transactions on Computational Intelligence and AI in Games, Vol. 2, No. 4, pp. 239-250. **Citation score: 55**