

Minecraft Related Master's Theses : Towards Next Generation AI

Q. Gemine, Prof. D. Ernst

May 7, 2013

Introduction

Over the past decades, video games have become increasingly popular and complex. Virtual worlds have gone a long way since the first arcades and so have the artificial intelligence (AI) techniques used to control agents in these growing environments. Tasks such as world exploration, constrained pathfinding or team tactics and coordination just to name a few are now default requirements for contemporary video games.

Among the wide variety of genres, open world games have led to the emergence of incredible virtual worlds. In such games, a lot of freedom is given to the player which can interact in many ways with the environment. The path that has to be followed to fulfill a task is almost never unique and even the very purpose of the game is often subjective, leading to affinity-driven objectives.

MinecraftTM

The last few years, MinecraftTM consolidated its position as one of the leading games within the open world community. As a Minecraft player, you arise in a procedurally generated world made of cubes. In light of its old school and distinctive graphical style, it produces surprisingly realistic landscapes that immerses you in an incipient adventure.

As pointed out by its name, mining and crafting are two main features of the game, where the first one aims at gathering raw materials for the second one. Quite logically, the quality and the utility of a manufactured object or tool is strongly dependant on the difficulty to stock up the goods needed for its construction. Once a player is familiar with these notions, the game unveils its most creative aspect : the construction of structures, ranging from simple huts to oversized castles.



Figure 1: A player equipped of an iron axis, ready to cut down a tree in order to gather some wood.



Figure 2: An impressive castle, highlighting that the creativity of the player is probably one of the most constraining limitation in Minecraft™.

Artificial Intelligence in Minecraft™

The intrinsic characteristics of Minecraft make it a very suitable challenge for state-of-the-art artificial intelligence techniques. Indeed, the variety of possible goals that an intelligent agent could pursue in the game is wide and it thus enables to conduct several works, each one aiming to succeed at a specific task.

Here are some examples of what could be studied in the context of a master's thesis:

- Gathering as much as possible of a specific resource, starting from scratch or with a basic set of tools.
- Building a given structure (small house, ...), including or not the gathering of the required resources.

- Trying to survive as long as possible (find food, craft weapons to deal with the monsters during the night, fight, ...).
- Developing a novel pathfinding algorithm, benefiting as much as possible of the interaction with the environment (destroying or adding blocs to create shorter paths, ...).

Potential AI Techniques

In this small section, we provide a non-exhaustive list of known artificial intelligence techniques to help you to search the web for relevant materials :

- Reinforcement learning
- Supervised learning (and eventually unsupervised learning)
- Monte Carlo tree search
- Mathematical programming (in particular, multistage stochastic programming)
- A* and Dijkstra's algorithms (pathfinding)

We also advice some courses that can help you to assimilate some important concepts in the fields of artificial intelligence and optimization :

- [ELEN0062-1](#): Applied Inductive Learning - Pierre Geurts, Louis Wehenkel (for statistical learning and machine learning in general, highly recommended).
- [INFO0049-1](#): Knowledge Representation - Pascal Gribomont (to familiarize with tree search techniques)
- [MATH0461-1](#): Introduction to numerical optimization (english language) - Quentin Louveaux (to assimilate key concepts in mathematical programming)

Typical Workflow

What is the typical workflow for a thesis about AI and games? Figure 3 aims at giving you an overview about it.

In addition, successful works can lead to the opportunity of writing a research paper for one of the international conferences in artificial intelligence and/or video games.

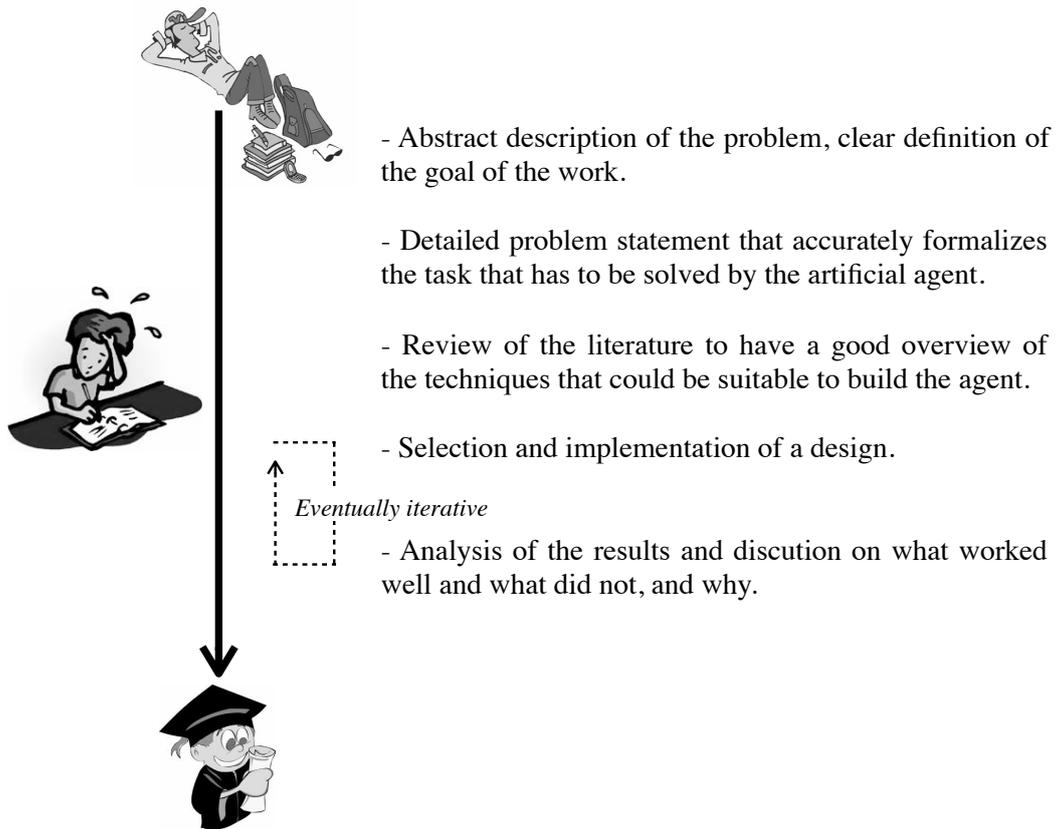


Figure 3: Typical workflow

Contact & Further Information

The supervisor for these master's theses is [Prof. D. Ernst](#) and the contact person for further information is [Q. Gemine](#). Suggestions from students related to other games than Minecraft are also welcome.