Computer **S**cience
Department

Multi Agent Systems

CMPT 862

Game: Hunters and Rabbits
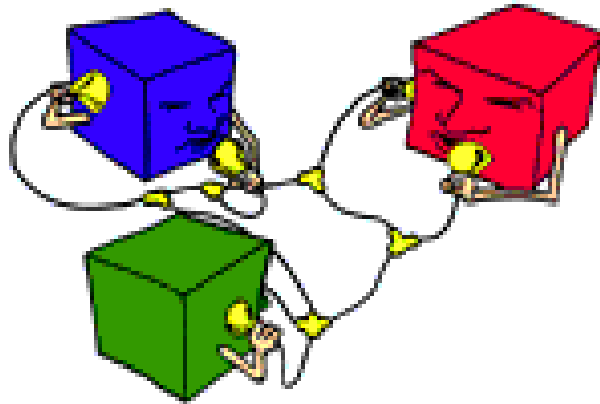
Project

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Contents

1. Main idea

Our game Hunters and Rabbits is designed as a multi-agent system. It is a reactive and proactive system in sense that all actor-agents interact with the environment and respond to the changes that occur in it in a timely manner and depending on their goals. Some actors in the system have a social ability – they interact with other actors from the same type in order to achieve their long-term objectives.

There are three types of agents in our application:
- Environment;
- Rabbit (prey, actor);
- Hunter (predator, actor).

The environment of the system is:
- Inaccessible – the agents do not have access to the whole world and have to deal with incomplete information;
- Deterministic – the state as a result from executing an action is certain;
- Episodic – the agent decides what to do depending on the current episode, i.e. there is no relation between the present and the next episodes;
- Dynamic – the user makes the environment dynamic by adding actors in it, i.e. not only the agents themselves make changes in the environment;
- Discrete – there are finite number of actions and percepts in the environment.

The world in our game is described by hunters and rabbits which are situated in an environment. The environment is represented as a finite grid where each cell is a square and can be occupied by one actor. In general the actors move with different speed and have different perceptions as they never see the whole map of the world. The hunters' goal is to catch rabbits and the rabbits' purpose is to escape from the hunters if possible. The predators cooperate between each other and coordinate their behaviors in order to trap the prey (only one hunter cannot have a success). The hunters group into packs that can consist of up to four members and one of them is a pack leader. Each member of the pack follows the leader's strategy – the leader decides which member on which side of the prey to go for a successful capturing.

A rabbit is captured in one of the following cases:
- The rabbit (R) is surrounded by four hunters (H):

	H	
H	R	H
	H	

- The rabbit (R) is surrounded by three hunters (H) and fence (#):

	H	#
H	R	#
	H	#

#	#	#
H	R	H
	H	

	H	
H	R	H
#	#	#

#	H	
#	R	H
#	H	

- The rabbit (R) is surrounded by two hunters (H) and fence (#):

#	#	#
H	R	#
	H	#

#	#	#
#	R	H
#	H	

#	H	
#	R	H
#	#	#

	H	#
H	R	#
#	#	#

When the prey is surrounded by the predators, it is being considered as dead.

The success in capturing the rabbit depends on different criteria. Small changes in the starting conditions could make a big difference in the behavior of the agents. All actors in the game are represented as animals with several features.

The properties of the rabbits are the following:
- Color* – The rabbit could be represented in different colors: white, pink☺, gray, brown, and black. The image of the rabbit agent is drawn in the selected color;
- Maximum look distance* – the maximum radius of the circle around the rabbit that it can see. If the distance is larger, the rabbit will be able to see more squares of the world ahead;
- Move time* – Time in milliseconds showing the interval between each move of the rabbit. The speed of the actor depends on the selected time;
- Fear factor – When the rabbit sees a hunter, its fear coefficient increases and it tries to escape from the predator.

The properties of the hunters are the following:
- Mood* – The hunter has a property to be in a different mood: happy, calm, hungry, and angry. The image of the hunter agent represents the actor's mood;
- Maximum look distance* – the maximum radius of the circle around the hunter that it can see. If the distance is larger, the hunter will be able to see more squares of the world ahead;
- Move time* – Time in milliseconds showing the interval between each move of the hunter. The speed of the actor depends on the selected time;
- Communication with other hunters – When a hunter sees a rabbit it tells the other predators using a predefined communication protocol. The other hunter-agents may decide to join the pack in the chasing of the rabbit or not.

* - The property can be defined by the user when the agent is created.

In the beginning of the game the environment is empty, i.e. there are no actors in it. The user decides what kind of and how many rabbits and hunters to add and to specify their features. When an actor is situated in the environment it starts moving around. The actor's behavior stays permanent while it does not observe an actor from the other type. If the agent is a rabbit its fear factor increases and it starts trying to escape from the predator. If the agent is a hunter it tells the other hunters for the discovery. If there is not a pack established for chasing this rabbit and the hunter does not chase another rabbit, the predator creates its own pack and starts chasing the prey. Other hunters can join the pack. One pack can contain up to four members. Each pack has a leader who decides the strategy that will be used in order to catch the prey. If the rabbit succeeds in running away from the hunters which respectively means that the hunters in the pack do not have any information about the rabbit's location, the rabbit is not afraid any more and starts walking around again. The hunters change their behavior from chasing to looking for a rabbit. If the hunters succeed in catching the prey, the rabbit is moved into the "storage" and the predators start looking for a rabbit again. In every moment of the game the user is able to add different actors in the environment and to follow their behaviors. The game is over when the user closes the GUI window.

4. User Interface

We have developed a nice looking user-friendly interface. The following screen shots show the main behavior of the implemented multi-agent system.
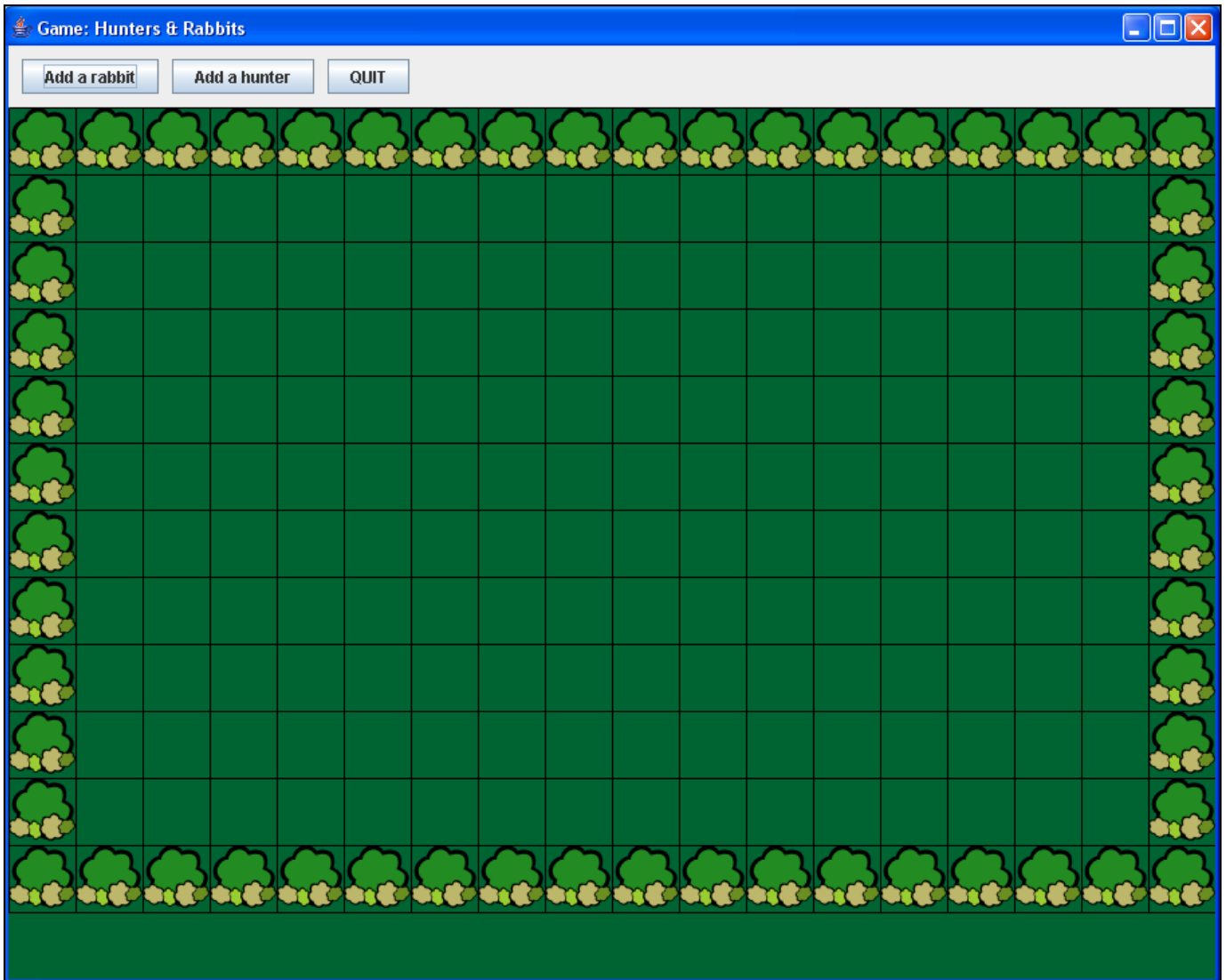
Screen Shot 1: Starting point of the game
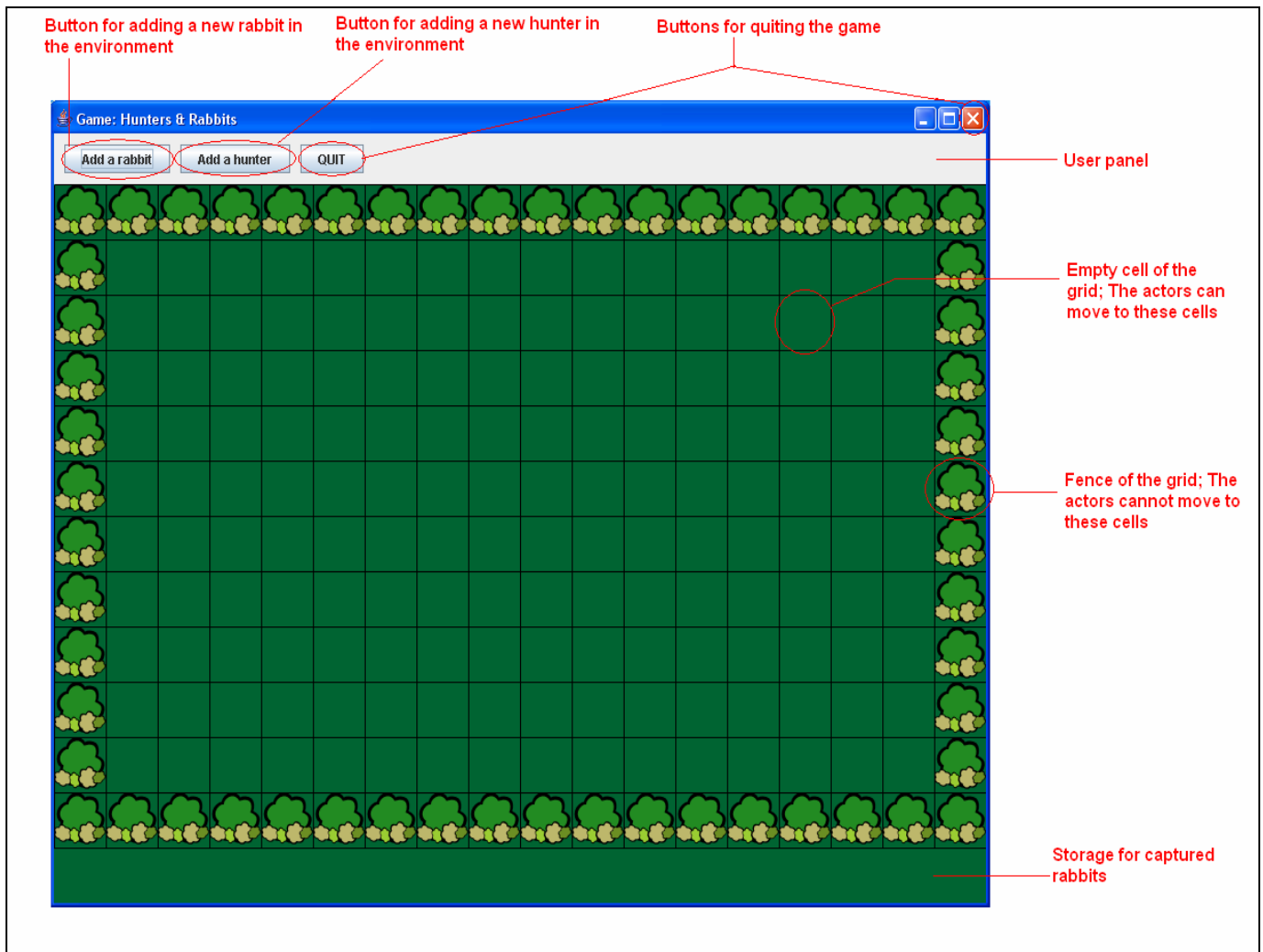
Screen Shot 2: Description of the starting point of the game

Actors in the game:
- Hunters

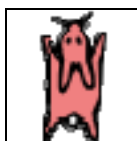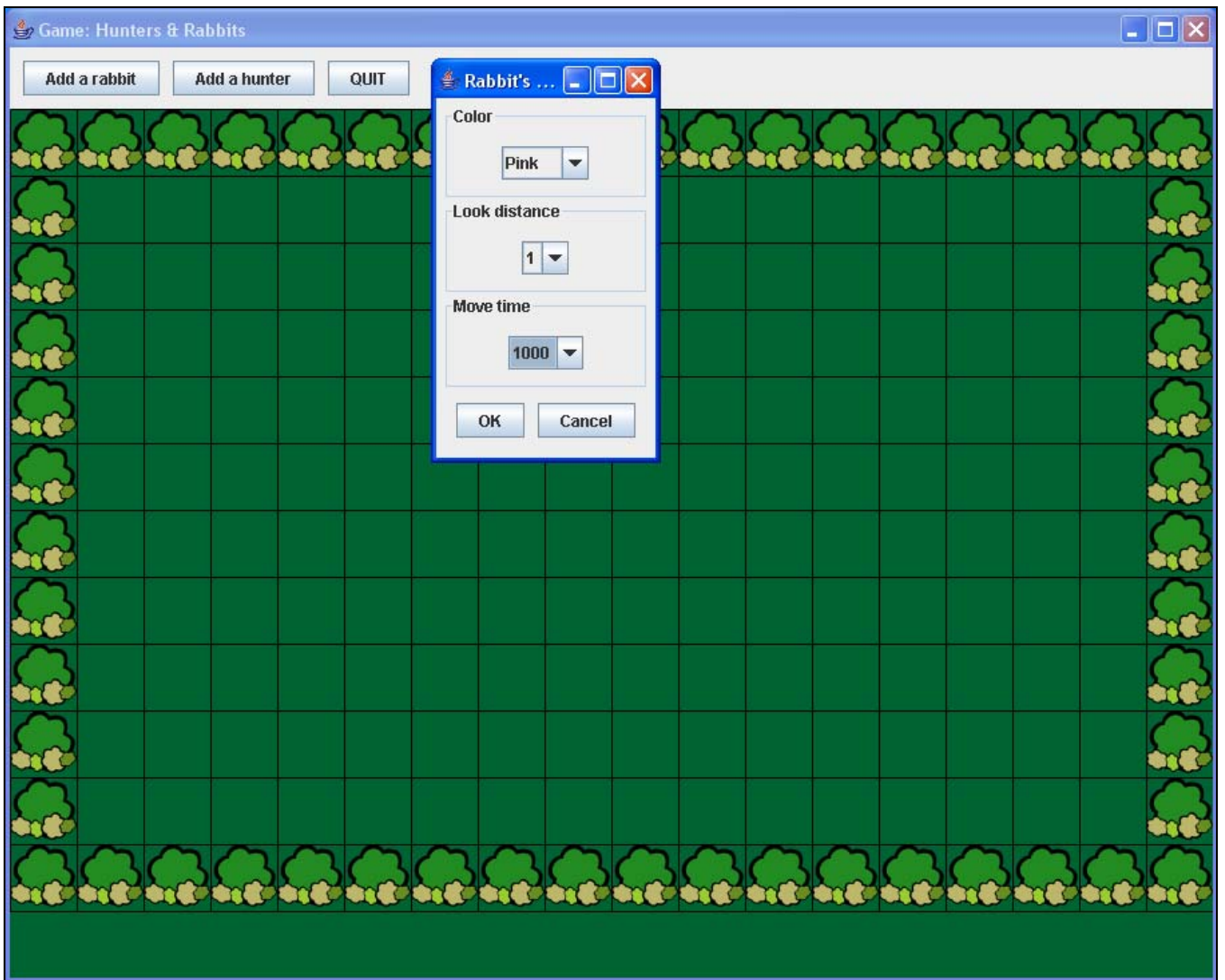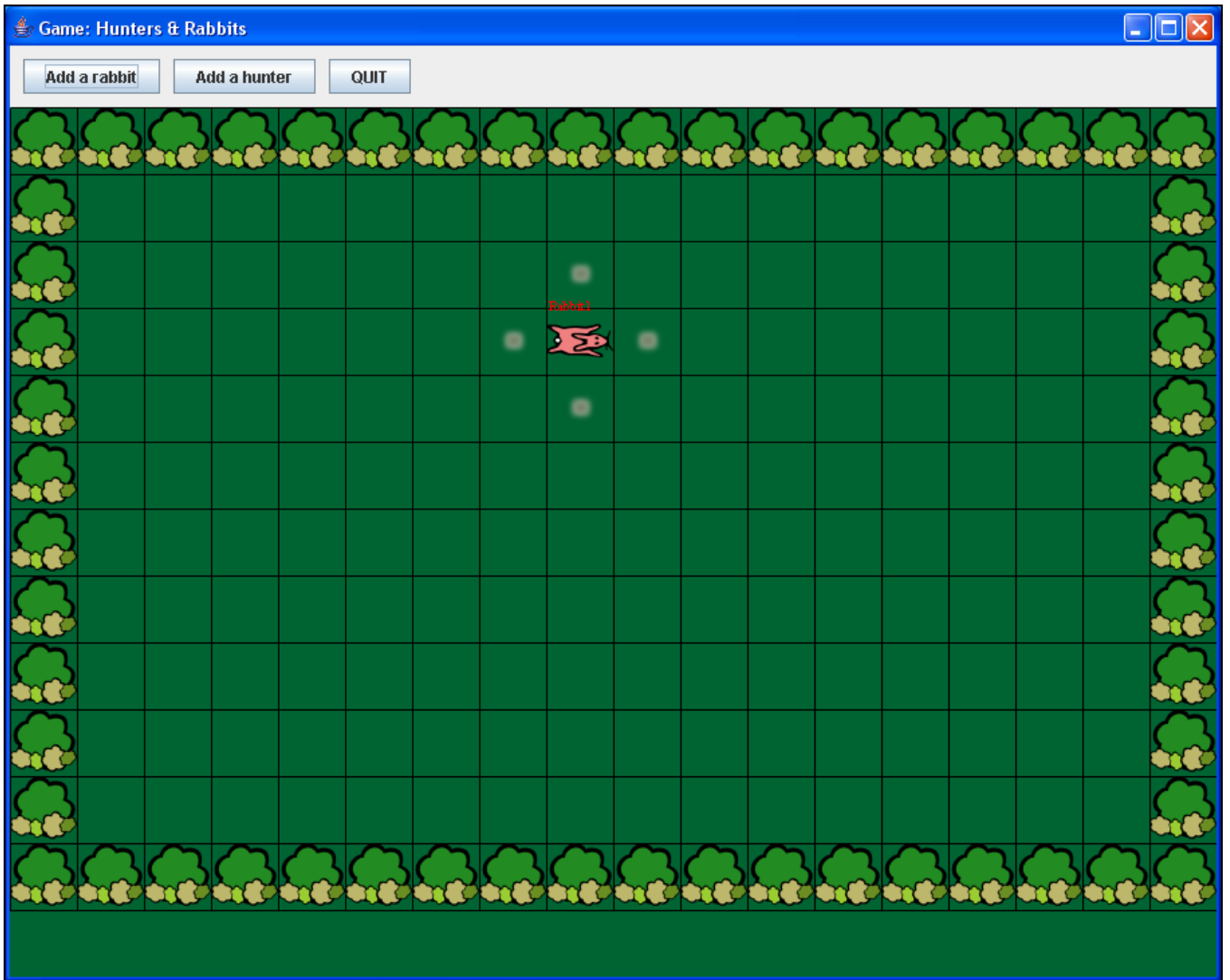| Happy | Calm | Hungry | Angry |

- Rabbits
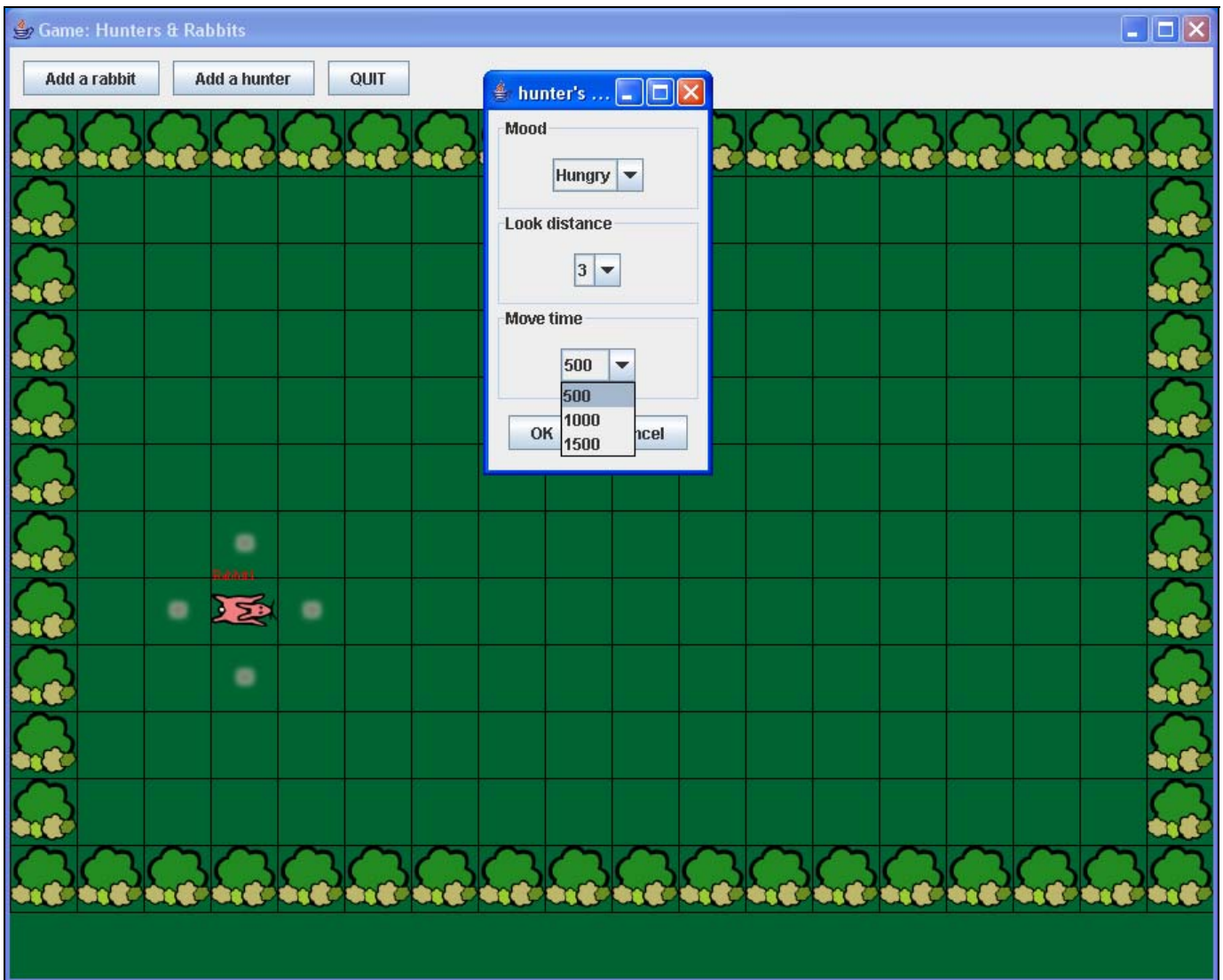

| White | Pink | Gray | Brown | Black |

Screen Shot 3: Adding a new rabbit to the world and setting its properties
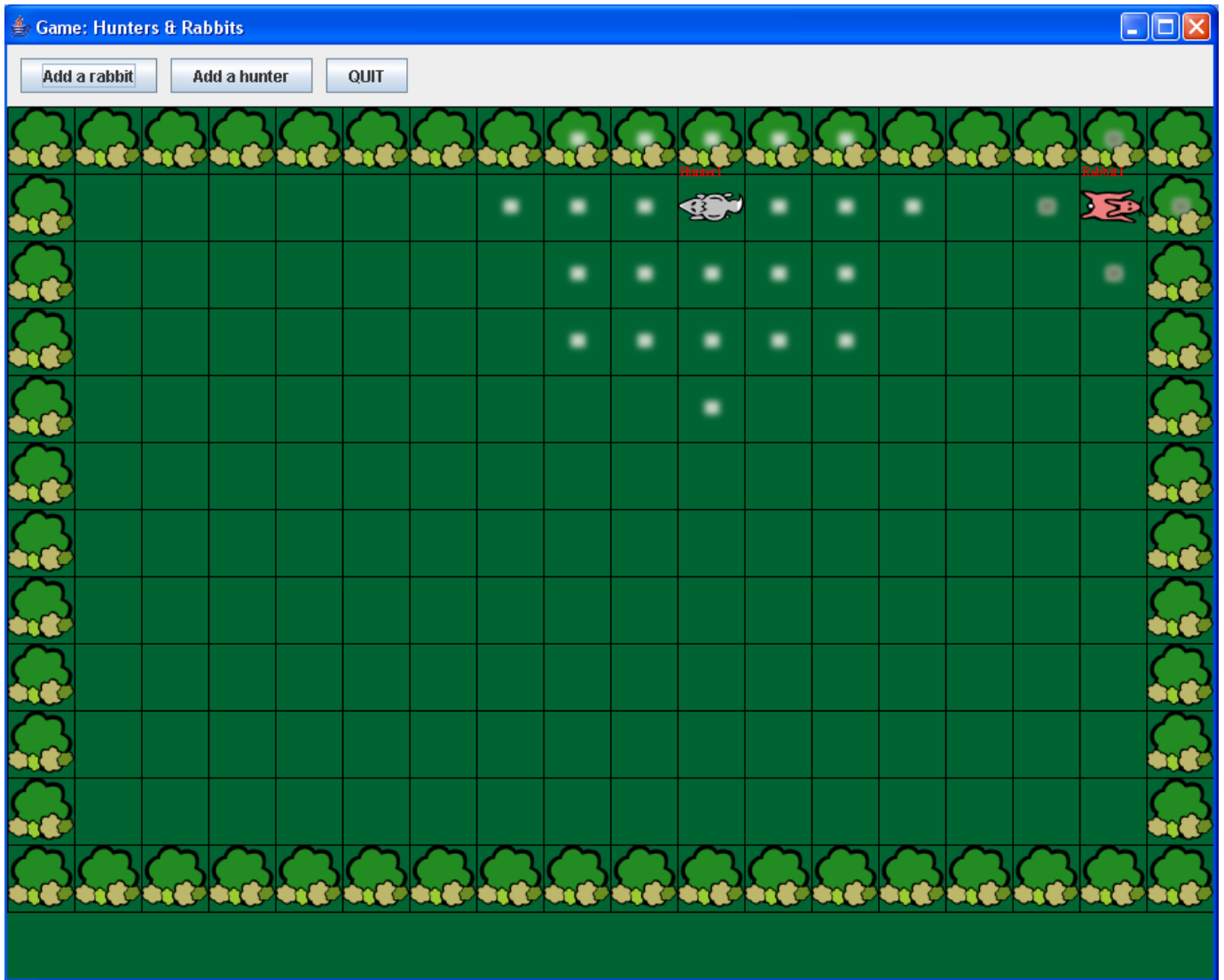
Screen Shot 4: A new rabbit is added to the world; The rabbit is pink, with look distance 1, and move time 1000 milliseconds

Screen Shot 5: Adding a new hunter to the world and setting its properties

Screen Shot 6: A new hunter is added to the world; The hunter is hungry, with look distance 3, and move time 500 milliseconds

Screen Shot 7: Four hunters are chasing the rabbit

Screen Shot 8: The rabbit is captured by the hunters; The rabbit is removed from the game and is put in the storage

6. References

[1] Multi-Agent Systems – An Introduction to Distributed Artificial
Intelligence, J. Ferber
[2] Multi-Agent Systems – Lectures, Term I, 2005
[3] An Introduction to Multi-Agent Systems, M. Wooldridge
[4] Applying UML and patterns, Craig Larman