Behavioral Modeling for Agents in Real Environments

Claudio Antonio da Silva
(cads@tecgraf.puc-rio.br)

Roberto de Beauclair Seixas
(tron@impa.br)

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Abstract

- Our purpose is to present a behavioral modeling for some applications using autonomous agents in real environments (geographical regions) and show that this can be an useful approach for simulation of complex systems (Military conflicts, Urban and Environmental phenomena, etc).

Agent-based Systems

- This is a highly heterogeneous field with many different, actually conflicting, viewpoints on what actually constitutes an agent. [See Ingham for a survey and discussion on agent's definition]
- "An agent is a system that tries to fulfill a set of goals in a complex, dynamic environment. When an agent is situated in the environment: it can sense the environment through its sensors and act upon the environment using its actuators." [Maes]

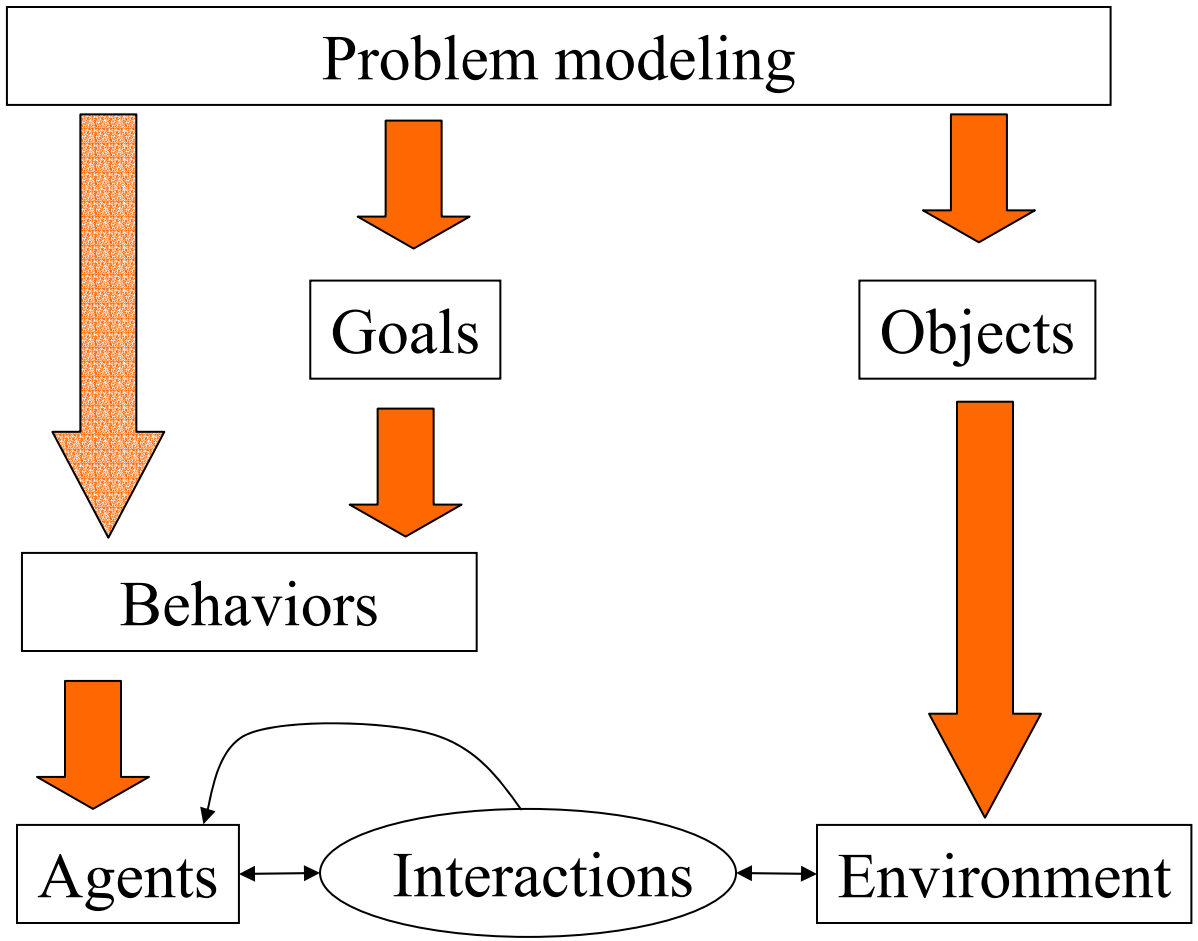
Agent-based Systems

- We need to define a software platform or architecture to develop agent-based software. StarLogo and Swarm are examples of such platforms.
  - StarLogo is known for its simplicity. It's based on Logo language, a computer language for children. Good choice for non-computer researchers.
  - Swarm is know for its flexibility and robustness. It's developed in Objetive C and may be extended using Objective C or Java. It's indicated for complex systems development.

Agent-based Systems

- Although our main purpose is behavior modeling, an architecture is needed to develop case applications.
- For our studies StarLogo is very simple and Swarm too complex.
- So, we define a simplified architecture which supports the main entities (agents, environment and some interaction events).

Agent-based Systems



Behavioral Modeling

- Although the term behavior has many meanings. In this work the term behavior is used to refer to the improvisional life-like actions of an autonomous agent. [Reynolds]
- The agent's behavior defines how it will act on the environment to reach its goals.
- Behavioral modeling is to identify the set of desirable procedures of an real entity of the system been simulated and implement them in the counterpart agent in the simulation.

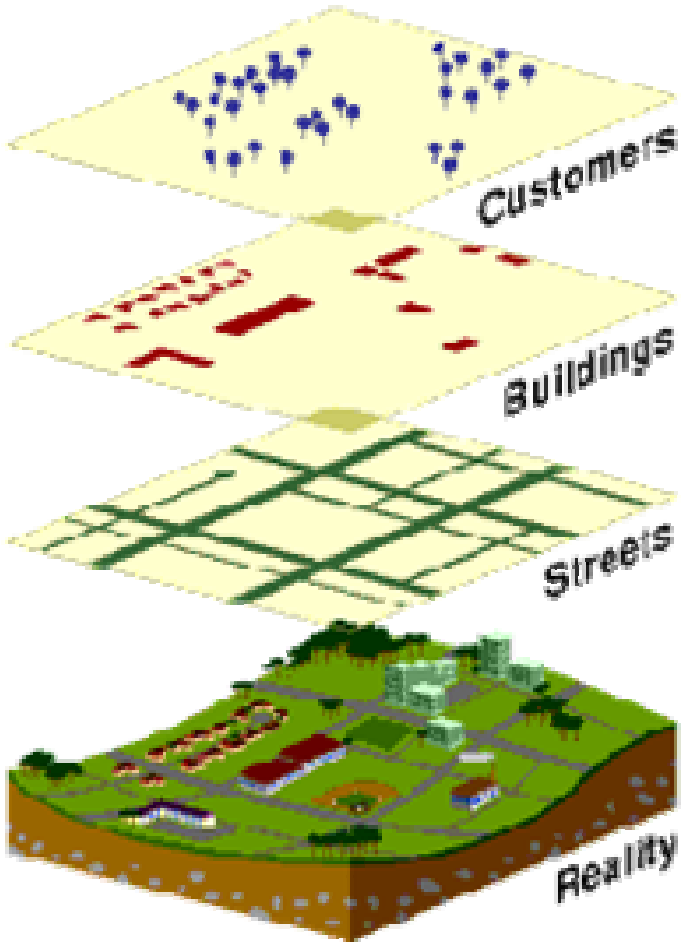
Behavior Modeling

We’re specially interested in steering behaviors that are those responsible for direct or control agents movement, in a real terrain with representation and layer structures of GIS.

Behavior Modeling

Environment:

Real terrain data with representations and layer structures of GIS



GIS and Agents Integration

- Applications in real environments require a representation of some portion of geographical space that may be stored in a GIS warehouse.
- Issues are:
  1. What GIS information can be used to represent the environment under study ?
  2. How to provide selected information in the agent-based system ?
  3. What cartographic projection for visualization ?

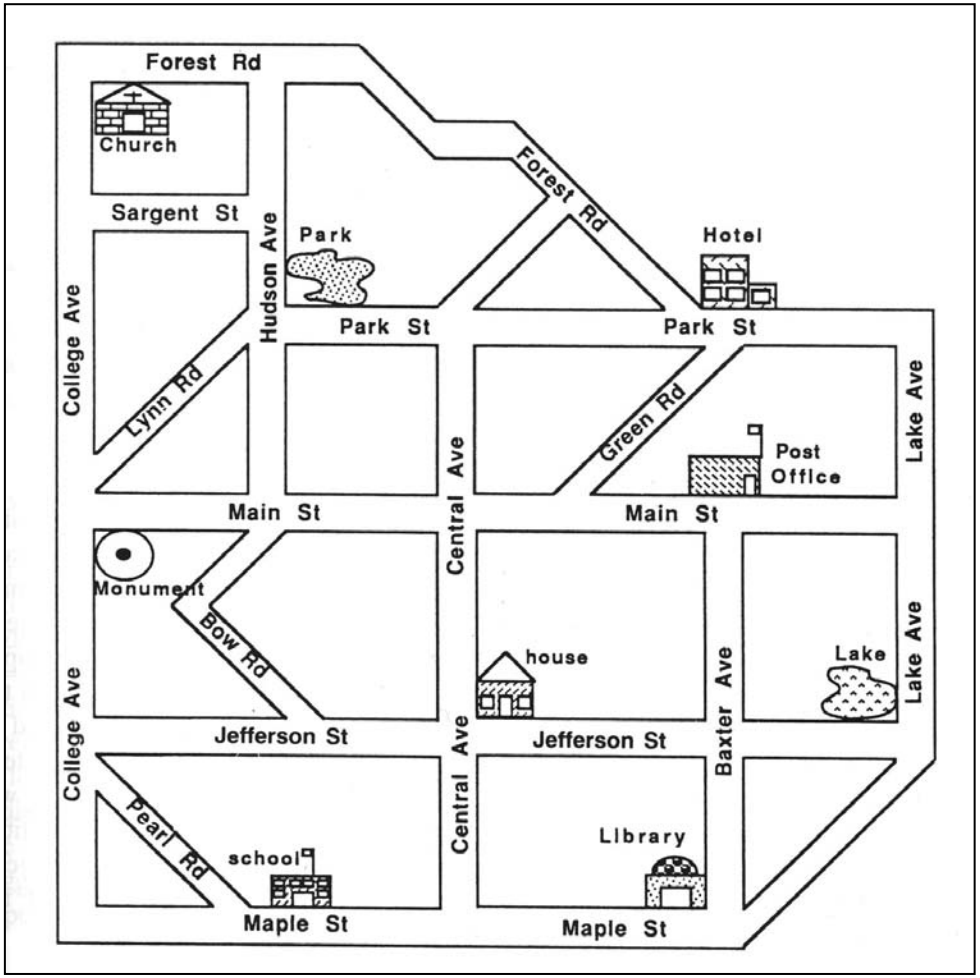
GIS and Agents Integration

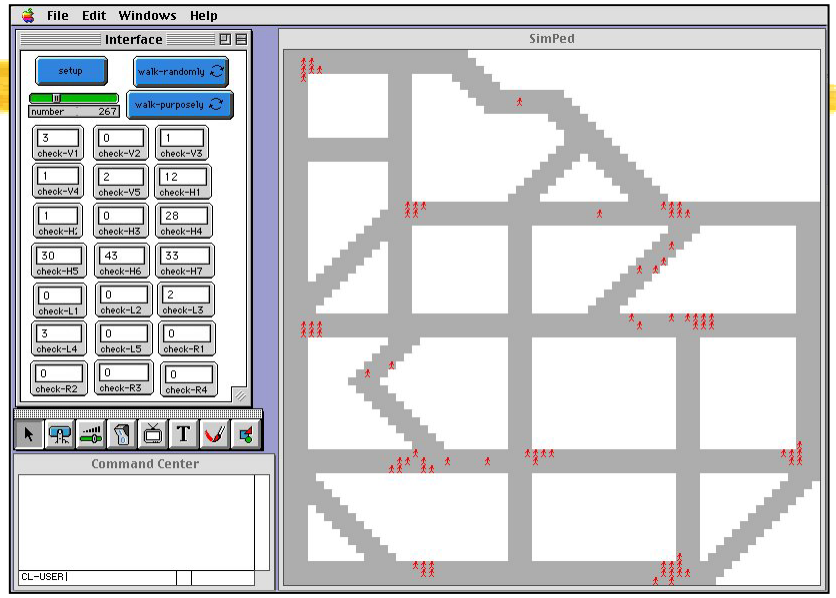
- Issues 1 and 3 are defined at application modeling.
- Issue 2 is architectural dependent. For our proposal we define that GIS must provide, at least, two information planes:
  - Trafegability map that will define terrain constraint to agents movement.
  - DEM that will be considered when agent is detecting visible objects (height fields).

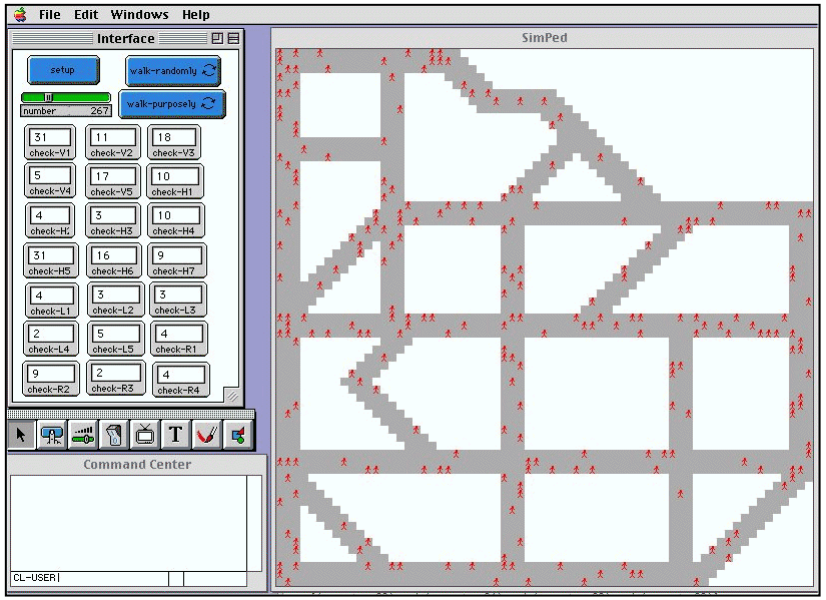
GIS and Agents Integration

- There are recent works been developed in this subject.
- Some examples of Bin Jiang and Gimblett.

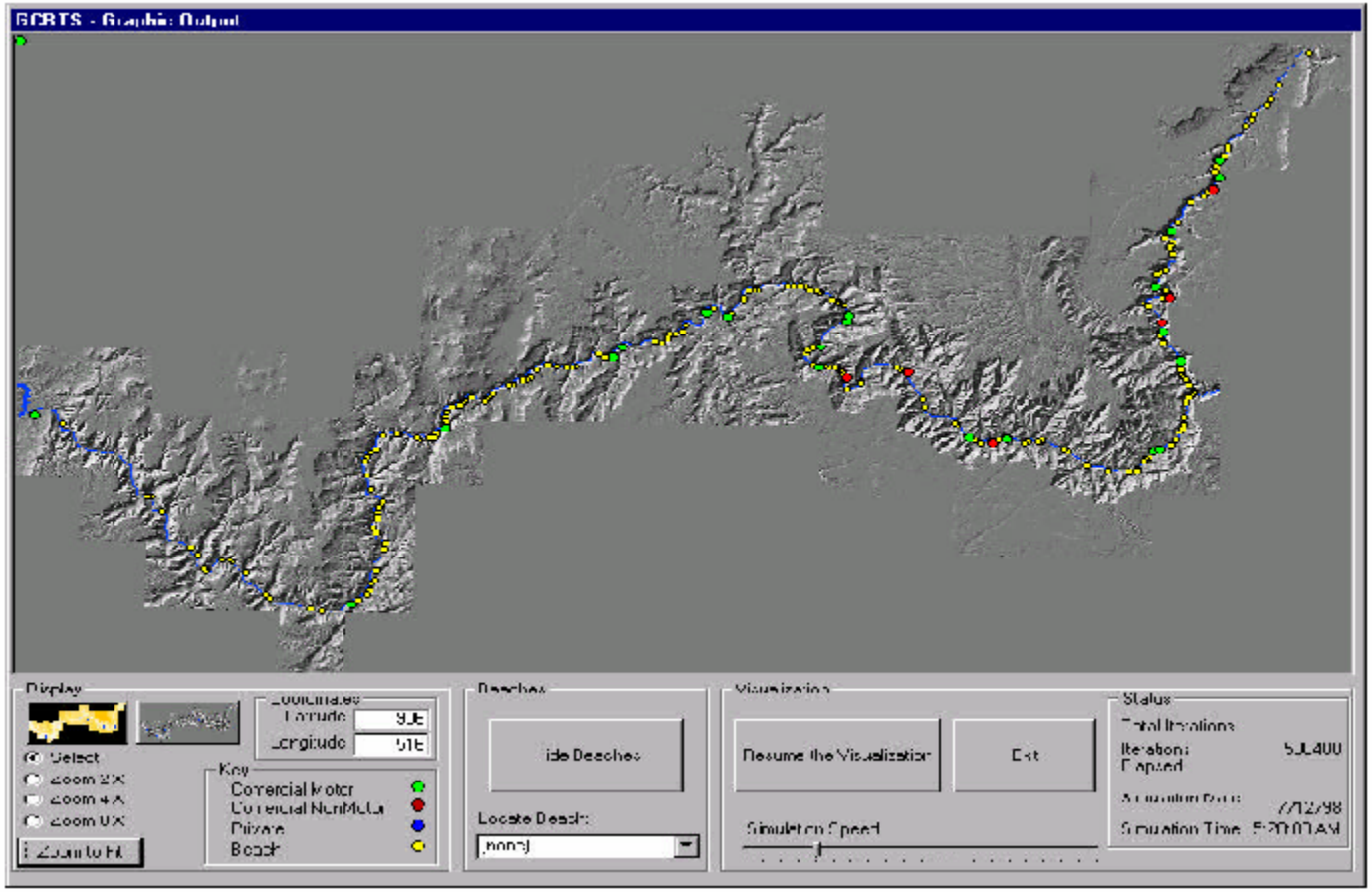
Bin Jiang Example: SimPed







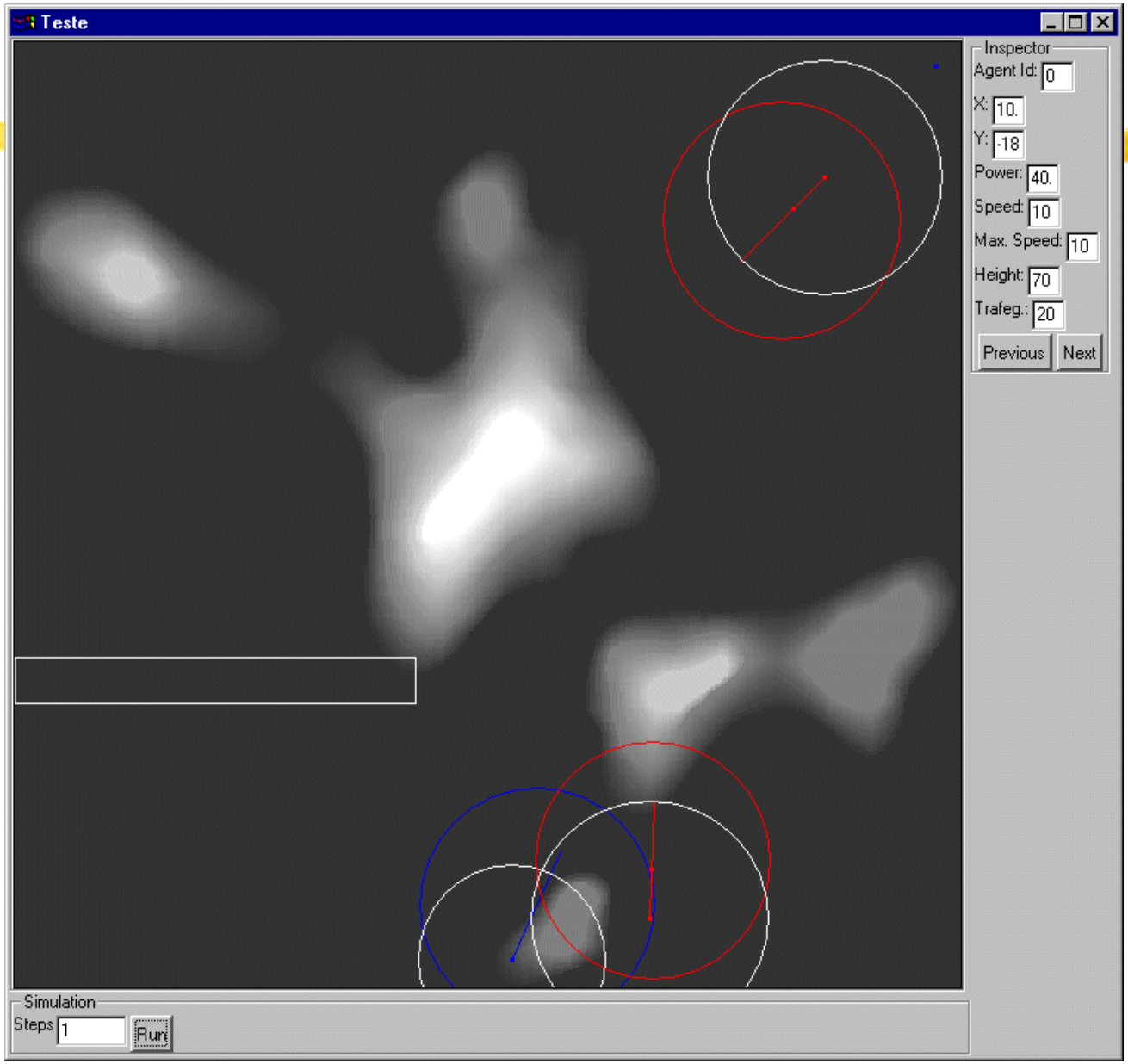
Gimblett Example:
Grand Canyon Rafting Trip Simulator



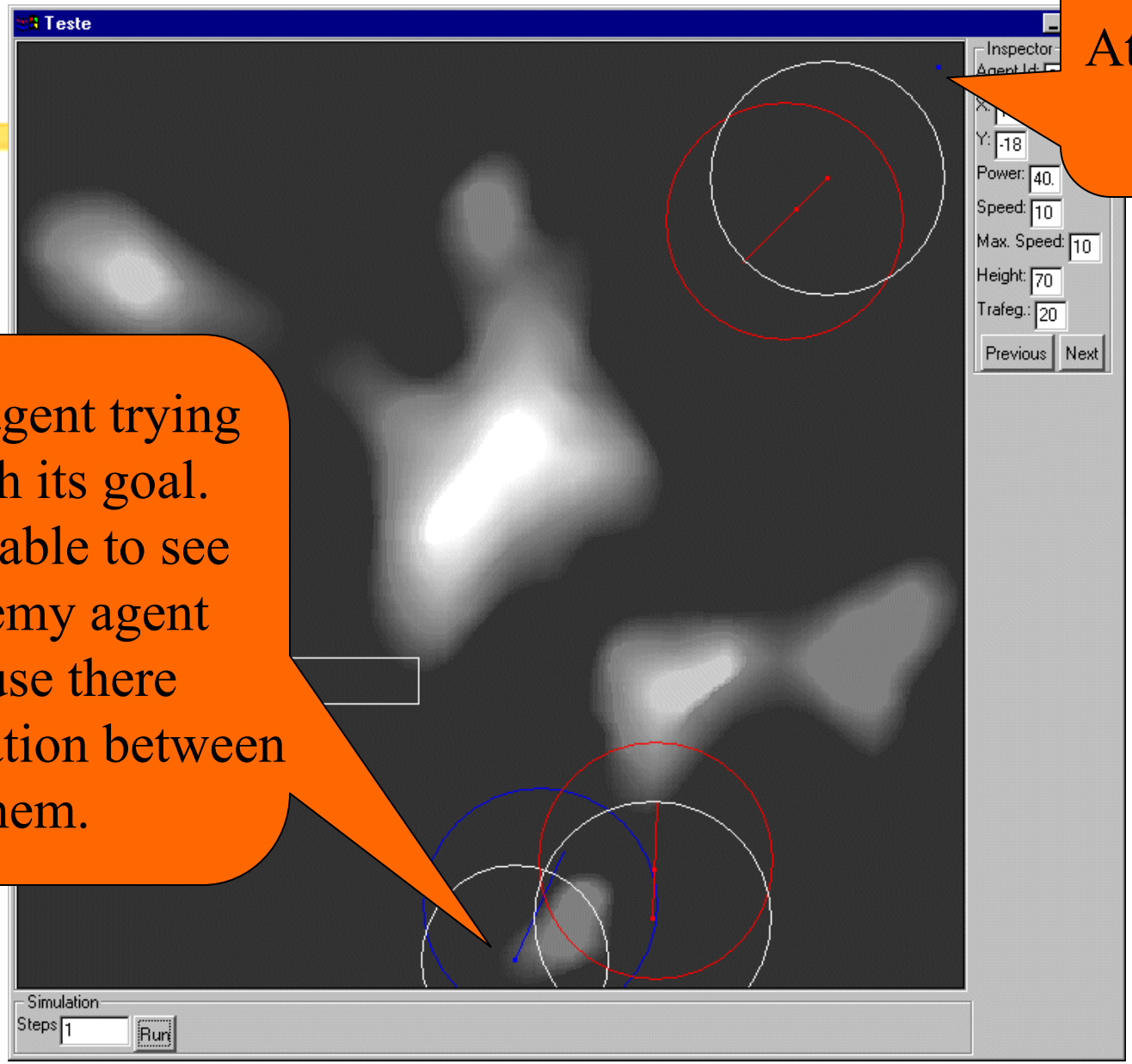
Cases

- We intend to present 2 cases of applications:
  - First, we're implementing a military application. It's a typical situation of defense versus attack combat. We designed some behaviors for defense and attack agents, and we're testing it to validate the model and framework.
  - The second application is not defined yet, but will be applied to consolidate the framework.

Military Application



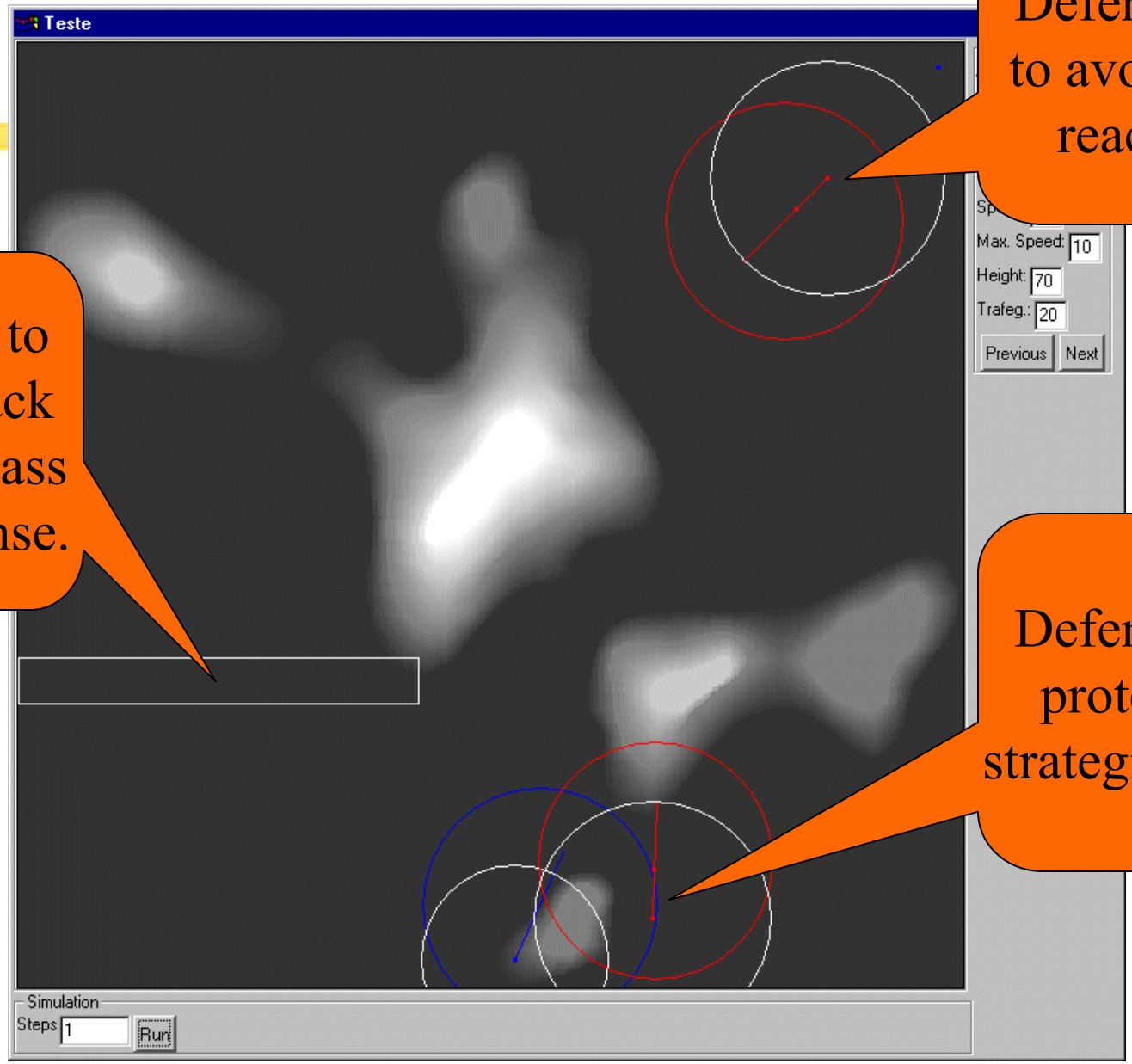
Military Application



Attack goal

Attack agent trying to reach its goal. It´s not able to see the enemy agent because there is an elevation between them.

Military Application

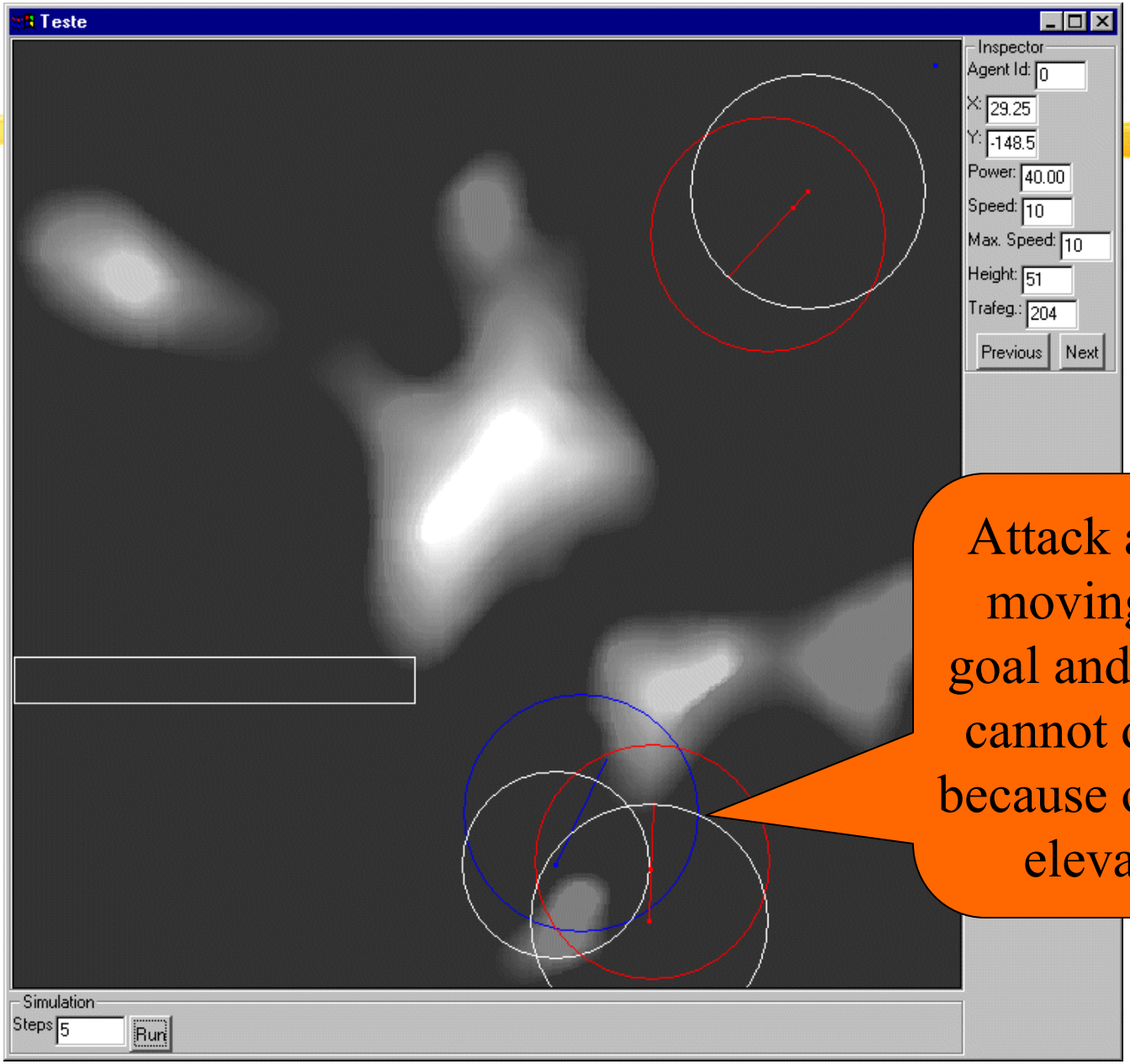


Defense agent to avoid attack reach goal

Obstacle to force attack agent to pass near defense.

Defense agent protecting a strategic location

Military Application



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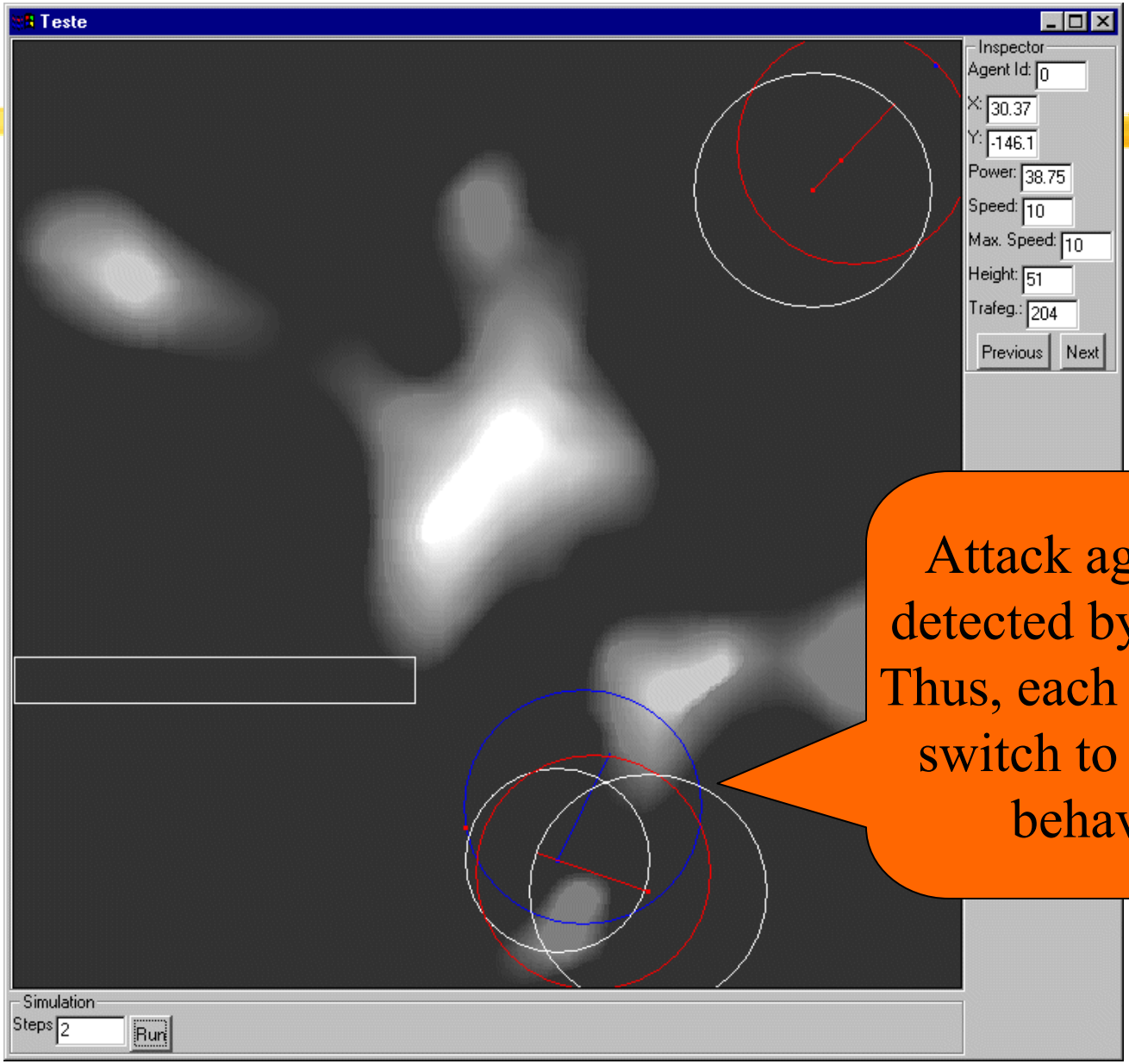
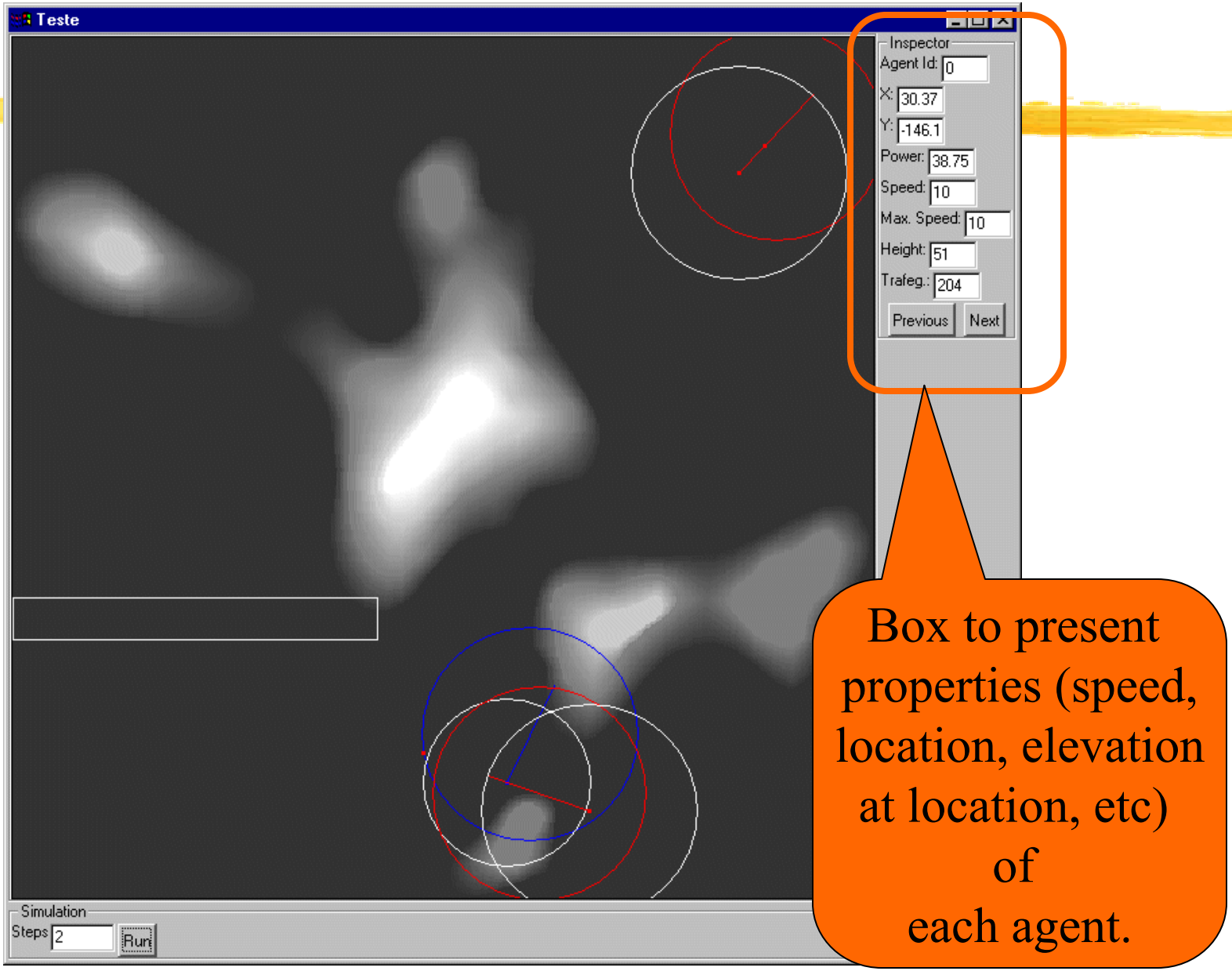


Military Application



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