An Agent-Based Simulation of the Battle of Kokenhausen (Extended Abstract)

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ABSTRACT

We introduce a new agent-based model of historical warfare, designed to maintain a structure of command between a regiment and its soldiers. It can model various tactics of different kinds of military forces and is simple enough to build massive simulations.

The model is used to simulate the Battle of Kokenhausen (1601), waged between armies of the Polish-Lithuanian Commonwealth and the Kingdom of Sweden. After producing results very close to historical data, alternative scenario of the battle is considered.

Categories and Subject Descriptors

I.2.11 [**Artificial Intelligence**]: Distributed Artificial Intelligence—*Multiagent systems*; I.6.5 [**Simulation and modeling**]: Model Development

Keywords

multiagent systems; warfare simulation; experimentation

1. INTRODUCTION

For thousands of years war was one of the most important phenomena affecting human culture. Numerous mathematical [3, 4, 5] and computer models were created in the hope of finding a way to predict the result of a struggle on the battlefield.

Ilachinski described benefits of simulating warfare with agent-based models, demonstrating them with his multi-agent systems ISAAC [1] and EINSTein [2]. Multi-agent systems also proved to be a useful tool for analyzing historical battles and conflicts. Agent-based models were created for both the Battle of Trafalgar [7] and the Battle of Isandlwana [6].

Unfortunately, in most agent-based models of armed combat agents act only on the basis of an inner set of rules [1, 7, 6], while in the real world all armies rely on the chain of command. Ilachinski proposed a multi-level agent hierarchy for EINSTein [2]. However, it would be hard to use in large-scale simulations.

We introduce a system with two-layered agent hierarchy, that allows an agent to fight as a part of a tactical unit, cooperating with his brothers-in-arms to achieve better performance. The model is simple enough to allow simulating battles with thousands of soldiers. At the same time, it is powerful enough to recreate tactics of number of types of military forces. The capabilities of the model are successfully tested on the example of the European warfare of 17th century, historical period yet to be analyzed by computer scientists.

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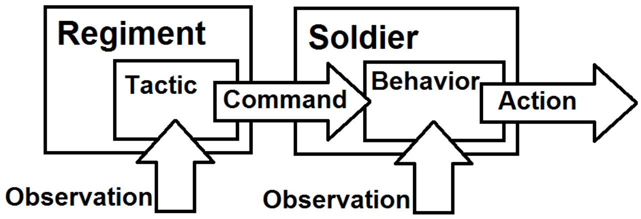

Figure 1: Scheme of the flow of information in the model.

2. THE MODEL

Two armies of agents take part in the combat. There are two types of agents: those representing soldiers of different types of military forces and those representing regiments.

Combat is conducted in consecutive rounds. At the beginning of each round, every regiment uses its *tactic*. Tactic is an algorithm that selects a command for regiment's soldiers. The decision is based on observation of the environment and knowledge about the state of the regiment (number and location of soldiers etc.). Examples of commands are *attack certain enemy regiment*, *move to certain position* or *regroup to formation*. Introduction of a tactic allows us to model cooperation more directly, unlike in other systems [1, 6], that force it to be done on the level of a single soldier.

Subsequently, every soldier uses his *behavior* to choose an action. Behavior represents the way the agent acts during the battle. It selects an action to be performed by the agent during current round, depending on observation of the environment and the command chosen by the agent's regiment. The type of behavior is usually determined by the type of armed forces the agent belongs to. Examples of actions are *attack certain enemy soldier*, *move across the battlefield* or *reload the weapon*.

At the end of each round system gathers all actions of soldiers and executes them in a random order. Battle is over when there is only one army with soldiers able to fight.

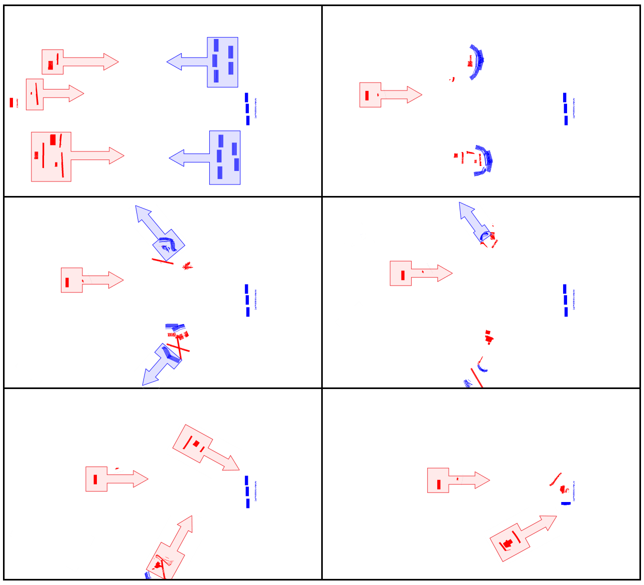

Figure 2: Course of the simulation of the historical scenario of the Battle of Kokenhausen (arrows showing the direction of movement were added later).

3. THE BATTLE OF KOKENHAUSEN

The Battle of Kokenhausen took place on the 23 June 1601. Polish forces (ca. 3300 men) defeated the army of Sweden (ca. 5000 men). The battle is very well documented, unlike many other encounters from 17th century. Historical data allowed us to precisely set the number of soldiers in each regiment of the Polish army. We approximated the number of Swedish soldiers according to available information.

Some characteristics of the model, such as damage done by soldiers or their speed of movement, required calibration. We built the simulation using bottom-up design. We calibrated the model on the smaller, less complicated confrontations, such as fight of two regiments of cavalry on one of the flanks. Then we used so determined initial parameters for more complicated simulations – for example confrontation of whole wings of armies – and finally for the whole battle.

Course of the simulation reenacts the actual battle, as shown in Figure 2. Cavalry of both armies clashes at the flanks. Left wing of Polish forces dominates the enemy after getting help from the main group. On the right wing Polish cavalry also manages to defeat the enemy. Battle ends with the destruction of the abandoned Swedish infantry.

Results of the simulation, in terms of the number of fallen and routed soldiers, are very close to the historical data. This shows that described model can be a valuable tool for reproducing results of historical battles. Running the simulation on a home-class PC with dual-core 2.93 GHz processor and 4 GB of RAM took less than 3 minutes.

4. AN ALTERNATIVE SCENARIO OF THE BATTLE

Historians believe that one of the most important reasons of such severe Swedish defeat was caracole, tactic used by their cavalry. Caracole was developed as a way of fighting enemy infantry. Using it against melee cavalry repeatedly proved to be ineffective (Kokenhausen (1601), Weissenstein (1604), Kircholm (1605)).

Alternative scenario of the Battle of Kokenhausen considers what would have happened, if Swedish reiters had used tactic designed to face melee cavalry. To check that, we replaced the original tactic and behavior of reiters with the tactic and behavior of Tatar riders of the period. All other parameters of the simulation remained the same, including numerical statistics of reiter soldiers and initial positions of both armies.

This time, Swedish cavalrymen manage to keep distance from the enemy long enough to deal serious damage with their firearms. Despite sustaining severe losses, Swedish army forced adversaries to retreat. Results proves the change of reiters tactic to be crucial in turning the tide of battle, thus confirming assumptions of historians.

5. SUMMARY

We conducted an experiment in using agent-based model to simulate historical warfare. Adding a second layer of agent hierarchy – the regiment agent – allowed us to model tactics of various types of military forces from 17th century. We combined modeled troops together in a single simulation and recreated the course of the Battle of Kokenhausen (1601). Finally, simulating an alternative scenario of the battle confirmed thesis of historians, that the use of the caracole tactic was one of the main reasons of Swedish defeat.

Results achieved during simulations show that our model can be useful in reconstructing course of historical battles. At the same time, a simulation with thousands of agents could easily be run on a home-class PC. It shows that there is a middle ground between simple systems designed only for a single battle and complicated, multi-level agent hierarchies.

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