

Multi-Agent Simulation of the Battle of Ankara

Introduction

For years, historians argue that the betrayal of Anatolian and Rumelian cavalries was the major reason behind Ottoman's defeat at the hand of Tamerlane. In 1402, the battle took place at the north of Ankara. Here, I intend to use simple rules to simulate the Battle of Ankara, thereby exploring what actually determines the outcome.

Objective

This study focuses on the question: is there a decisive factor that alone can determine the battle outcome? If not, what are the important factors?

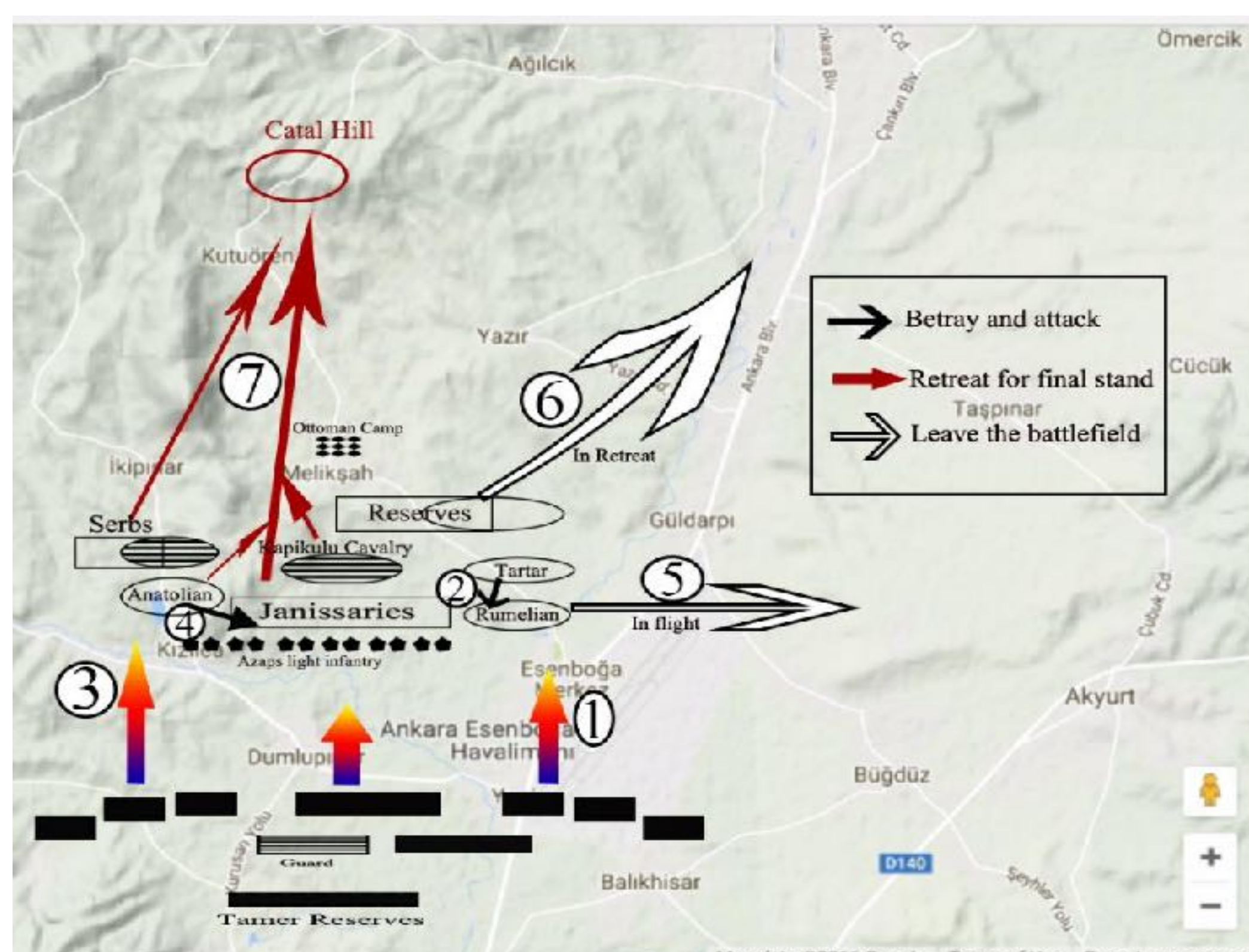


Figure 1. Battle procedure. Tamerlane troops are represented by black rectangle.

Simulation

- Implemented in C++, without other tools.
- Agent-Based: 116 Agent with Ottoman (55) and Tamerlane (61).
- Each agent is a military unit of a certain number of soldiers who shared the same training background, similar weapons and armors.
- The flow of actions and states is based on a finite state machine in Figure 2.

Data

- 4320 battles (instances).
- 1 Class {Ottoman Victory, Tamerlane Victory, Draw}
- 5 Attributes (possible factors to the defeat)
 - Ottoman endured a forced march
 - Ottoman soldiers drank poisoned water
 - Ottoman was on the defensive
 - Betrayal took place in Ottoman wings
 - Ottoman could have more soldiers



Figure 3. As Ottoman has more soldiers, the chance of Ottoman victory boosts to

Analysis

- Graph
 - When Ottoman size is increased to 127K, chance of Ottoman victory rises from 0 to 3.3%. When Ottoman has 140.5K soldiers, the chance is boosted to 90%.
 - Betrayal will eliminate all chances of Ottoman winning.

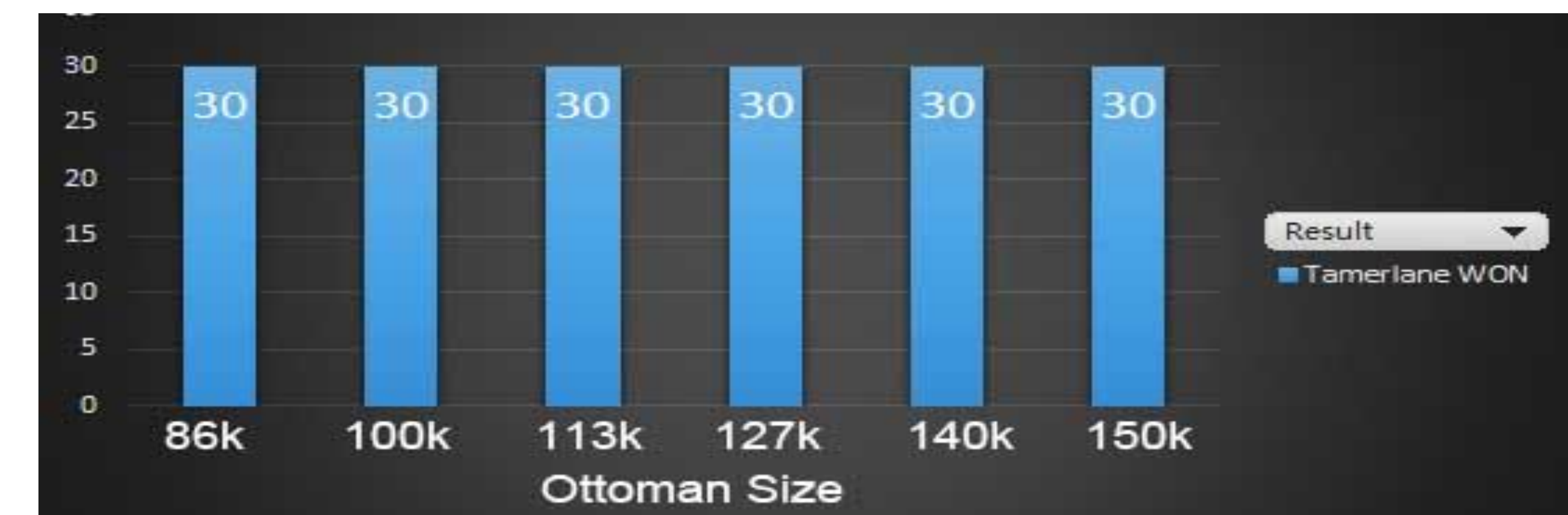


Figure 4. The chance of Tamerlane Victory is 100%, no matter how large Ottoman Size is.

Eval+Ranker	SubsetEval + BestFirst	SubsetEval + Greedy	Wrapper + Greedy	InfoGain + Ranker	GainRatio + Ranker
Result	95.66	95.66	82.06 *	97.02	97.02
Compare	Though better than Wrapper + Greedy, SubsetEval + BestFirst has no statistical significance with the rest.				
	After Remove Betrayal		After Remove Size		
Result	80.56		82.20 v		
Compare	The first data set is significantly worse than the second				

WEKA

- J48 does not have statistical significance to other classifiers (except *NaiveBayes*).
- AttributeSelection* Classifier: There is no statistical significance among different rankers and evaluators (except *Wrapper + Greedy*). Those classifiers disagree with the ranking of the first two most important factors (*Betrayal* or *Size*).
- Compare accuracy after remove certain attribute. Removing Betrayal will result a significantly worse accuracy. Therefore Betrayal is the most important attribute.

Result

Most important factor is *Betrayal*! With descending importance, the rank is *Betrayal*, *Size*, *Offensive*, *Poison*, and *Constantinople*.

To reach a counter-factual result(Ottoman Victory), Ottoman must have more soldiers than 127K, with no betrayal, and are better to be on the offensive.

Future Development

I plan to deviate the fixed numbers and initial values and try to find one set of those numbers best characterizing the battle

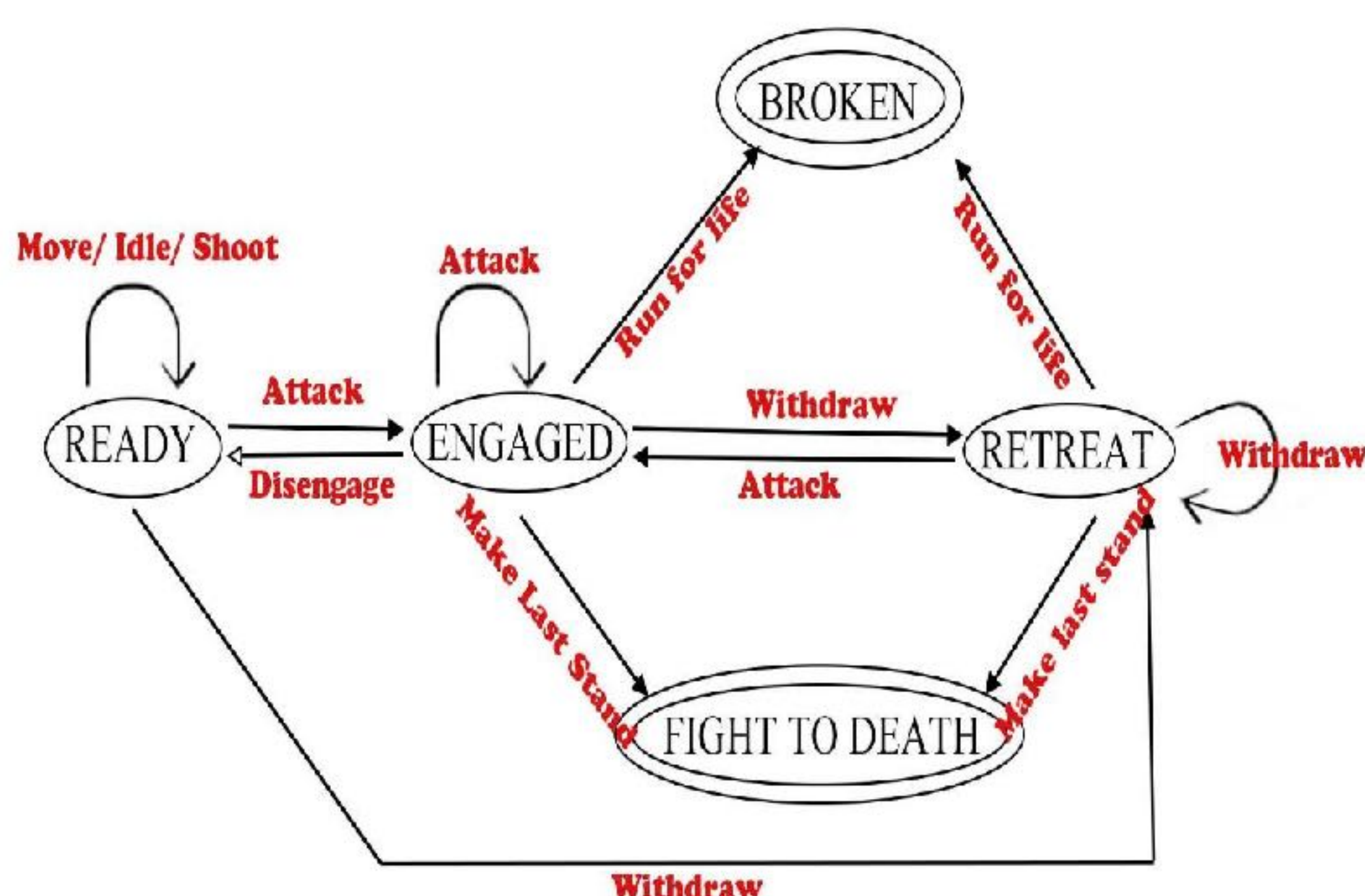


Figure 2. the Finite State Machine controls the actions and states of the agent