Probabilistic Methods for State Estimation

Ifechukwudeni Oweh, and Sotirios Diamantas

Department of Computer Science & Electrical Engineering
Tarleton State University, The Texas A&M University System
Box T-0390, Stephenville, TX 76402
ifechukwudeni.oweh@go.tarleton.edu, diamantas@tarleton.edu

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1 Introduction

The challenge background given explains that the Navy is ongoing an investigation on AI/ML capabilities to enable rapid and automated weapon pairing which will enable identification of the best engagement actions and weapons pairings to defeat various notional threats. In the following paragraphs we would give a detailed explanation of an approach with the primary purpose of developing an algorithms for the automated scheduling and coordination of simulated directed energy, hyper-velocity projectiles, and other advanced weapon systems, the algorithm ought to trigger their agents to respond to various adversarial actions, demonstrating the advantages of AI/ML integration into their systems and war fighting capabilities.

1.1 Proposed Approach

The first approach would be keeping track of state of agents continuously using the equipment data set of the friendly agents, developing a best subsets selection, and forward selection process using a greedy search algorithm effectively pair up equipment's and weapons with the goal of matching up to be able to overpower enemy equipment and weapon state while considering pairing up equipment's and weapons whose state exceed the threat level of the enemy in order to save and reserve weapons.

To achieve the first approach, we would be incorporating Markov Chains.

A Markov chain is a mathematical process model used to predict the state of a system in the future and describe a process where the future state of a variable is dependent only on the current state of that variable, not on any previous states. This is useful for tracking the state of variables in a data set, because it allows us to make predictions about future states based only on the current state. For example, if we have a data set with a variable that can take on the values A, B, and C, and we know that the variable is currently in state A, we can use a Markov chain to predict that the variable will be in state B at the next time step.

The Markov chain process works by first identifying the states of the system, which can be any set of values. For example, in the case of the automated scheduling and weapons pairings, the states could be the different types of weapons, the different types of oppositions, and the different times of day.

Next, the transition probabilities between states are calculated. This is done by looking at the data and determining how likely it is for a transition from one state to another to occur. For example, the algorithm might determine that there is a 70 percent chance that a weapon will be effective against a certain type of opposition at a certain time of day.

Finally, the Markov chain is used to predict the future state of the system. This is done by starting in the current state and then using the transition probabilities to determine the most likely state in the future. For example, if the current state is that a weapon is effective against a certain type of opposition at a certain time of day, the Markov chain would predict that the weapon will continue to be effective against that opposition at that time of day.

A second approach would be incorporating and developing a machine learning algorithm using a supervised learning technique and a statistical classification method. This essentially carries out mathematical based decision-making and uses the knowledge of prior events to predict future events. A supervised learning technique could be used to train the classification algorithm. This would involve providing the algorithm with a set of data that has been labeled. The algorithm would then learn to classify the data into different groups.

A statistical classification method could be used to validate the results of the classification algorithm. This would involve using a set of data that has not been labeled. The classification algorithm would be run on this data, and the results would be compared to the known labels. This would allow for the accuracy of the algorithm to be checked.

Naïve Bayesian classification would be an effective algorithm to tackle the problem given. Bayesian statistics is a way of calculating probabilities based on a set of data. Naïve Bayesian classification is a type of classification that is based on Bayesian statistics. In this type of classification, the data is classified into different groups based on the probabilities of the groups.

Bayesian statistics given a prior probability, derived from training data sets, can update the state of the model by considering current and past observations. In particular, as new data enter our model the updates and predictions will be coming more and more accurate. The classification algorithm is used to group the data into different categories. This is done by looking at the relationships between the variables.

Once the data is classified, the Bayesian statistics can be used to calculate the probabilities of the different groups. This information can then be used to update the current state of the agents which trigger another action, such as automated scheduling or weapons pairings. The goal is to use the information to defeat various oppositions.

In conclusion, there are two approaches that could be taken in order to automatically schedule and pair weapons. The first approach would be to use a Markov chain in order to track the state of the variables and make predictions about the future state of the system. The second approach would be to use a supervised learning technique to train a classification algorithm. This algorithm would then be used to group the data into different categories. Bayesian statistics would then be used to calculate the probabilities of the different groups, clusters various data points then updated the current state and predictions done by the Markov chain based algorithm