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BEHAVIORAL ANALYSIS OF AGENT BASED SERVICE CHANNEL DESIGN USING NEURAL NETWORKS

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ABSTRACT

The integration of neural networks into agent based models can provide a better understanding of dynamic agent responses when modelling complex systems. Additionally, due to the nature of agent based models and the networks that exist in them, individual neural networks can be trained in a supervised learning environment and assigned to individual agents. The advantage of using this approach is that individual agents become more unique (Samuelson and Macal, 2006), and make decisions based on what the neural network has learned during the training phase. Also, in this work the neural networks are trained based on data collected from human-based simulations, due to this, individual strategies learned by the neural network can be translated to individual agents. Integrating neural networks into agent based models can provide more realistic simulations.

1 INTRODUCTION

Agent based modeling and simulation (ABMS) has been applied to many fields, including but not limited to: biology, economics, marketing & communication (Macal and North, 2006). Using ABMS to simulate and predict complex systems' behaviors is especially advantageous when systems consist of nonlinear interactions and individual agents have different properties (Bonabeau, 2002). One notable drawback of ABMS is that as systems become larger, more computational power is required; however, this is due to the fact that agents communicate with one another. It is for this reason that when simulating systems where agents' choices effect one another and/or agents communicate with one another, ABMS is preferred. Another drawback to ABMS is that irrational behaviors that human exhibit may not be represented in the simulation. A possible solution for this drawback is to implement a neural network based system; this is achieved by using a neural network trained by collected human data to program simulation agents.

Training a neural network using multi-layer perceptron classifiers with collected data can create a network that can predict outputs given a set of inputs. Multi-layer perceptron classifiers, uses a method known as backpropagation, to minimize the errors the network makes when predicting outcomes during the training phase (sckit-learn developers, 2016). When the network minimizes the errors it does so by adjusting parameters within the network in hidden layers. It is important to understand that when using multi-layer perceptron classifiers, that a larger portion of developing a neural network involves tuning or optimizing how the network learns. Since ABMS is a good choice for systems where information is communicated between agents, multi-layer perceptron classifiers are better suited as the network can be tuned to learn different types of data. Integrating individual neural networks into individual agents, can create a more unique and dynamic system; furthermore, it creates a more realistic simulation.

2 TRAINING DATA

As neural networks require data for supervised learning, experimental simulations with human subjects was adopted in this research to train and test the accuracy of the neural network. Training data collected was for a service channel simulation where human subjects were asked to take over the decision making process of one agent out of 120. Human subjects were asked to make choices based on what they had expected to wait at each of the three possible locations. The same choice was asked to be made 45 times within the same simulation. The collected data from the simulation included what the subject expected to wait at each of the three possible service locations before making a choice and what service location they had chosen. The training data collected included the expected wait times and choices of 60 students, where the expectations formed the network's inputs and the choices its outputs. The network was then trained on 80% of the data set from a single subject and the other 20% was used to test the networks accuracy.

The reason individual networks are created is that, it is assumed that different subjects approach the simulation in different ways. It is true that some subjects use similar if not the same strategies; however, the way choices are made still vary between subjects. It is seen that there are definable clusters in subjects choices, and that multiple clusters can form even larger clusters; however, there are still a significant amount of outliers. Due to this using individual neural networks will capture how outliers make choices.

3 APPLICATION

The integration of individual neural networks into ABMS can improve the dynamics of models and can provide more realistic prediction of complex systems. Current ABMS struggle to predict systems where random/irrational behavior is present. In a system where agents choices effect one another and agents can communicate with one another, it is vital to a models reliability to capture the unique behavior of individuals in a system.

For example, the outcomes of most traffic queuing systems depend mostly on the agents within the system and how they interact with one another; therefore, creating individually unique and realistic agents for simulation is a must. By integrating individual neural networks into individual agents it is possible to achieve a more realistic and dynamic simulation.

This type of model can be applied to queueing based models as well as traffic modeling. Training data for the neural network could be collected from the following theoretical experiment. A selected group of subjects from one geographic, that all travel approximately the same distance daily to another geographic, where there is more than one possible route to take. Subjects would be provided with current traffic reports for each of their possible routes and then would be asked to report which route they selected for their daily commute and the expected travel time for all possible routes. This data would then be used to train individual neural networks and integrate them into individual agents for simulation. In theory this would provide a more realistic modeling of the queuing behavior present in traffic.

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