Multi-agent Simulation of Airline Travel Markets

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Abstract. This paper explores the use of a learning classifier system variant, XCS, in learning effective airline decision rules within the context of a multi-agent team simulation. From this study a general approach to modeling an airline market has been developed based on a multi-agent, team-based concept. Additionally, several preliminary trials of the simulation have been executed.

1 Introduction

Traditionally, the Local Airport Authorities (LAA) charge airlines a flat rate to land and depart from their airports regardless of a flight's arrival or departure time. Due to passenger preferences this policy results in heavy travel during the two "rush hour" periods - morning and early evening. In an attempt to encourage airlines to schedule their flights evenly throughout the day, thus easing congestion, we are interested in experimenting with variable pricing policies. This study investigates what the response of the individual airlines would be to the proposed change in pricing policy. The aim of this project is to accurately model the decision making process of the airlines using a multi-agent model, in which each airline is modeled by a cooperating set of teams (i.e., a "team-of-teams") that learn to work in concert to compete effectively against other similarly structured airline teams.

2 Multi-agent Model Structure

The agent model (Figure 1) consists of several teams comprised of learning agents that we call, Flight Agents, each representing a single flight (departure or arrival). Flight Agents are logically grouped into teams representing the specific routes that the airline services (Route Teams). Flight Agents must cooperate with the members of its particular Route Team. Additionally, the set of Route Teams as a whole must learn to cooperate with each other to optimize overall airline profitability. Furthermore, these Airline Teams must also learn to compete against other similarly structured Airline Teams for passenger market share. Each Flight Agent contains its own schedule that consists of the Fare, Time, and Capacity of the flight. Collectively, the Flight Agents represent the Airline's flight schedule for that airport.

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Each flight of an airline's flight schedule is evaluated in a simulation environment by the Passenger Demand Allocator Model (PDAM). The PDAM assigns a utility value to each of the flights and allocates passengers to these flights based on their relative utility values.

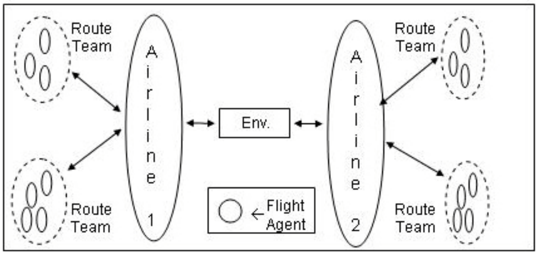

Fig. 1. Multi-agent structure for airline market.

3 Learning Algorithm

For this initial study each Flight Agent used a Learning Classifier System (LCS) [1] as its learning algorithm. Specifically, the LCS algorithm used was XCS [2], a variant of Holland's original LCS. The rules' conditions were comprised of 15 attributes divided among five categories: profitability, passenger load factor, market share, price, and arrival/departure time. The allowed actions for each flight agent included adjusting its own fare and time slot, selecting a smaller (or larger) plane, and deciding whether it should fly (thus allowing airlines to reduce the number of flights in a particular market).

4 Preliminary Results

Our preliminary results were inconclusive, however, promising enough to warrant further refining our airline market model. This study used very simplistic passenger demand allocation and flight utility models. Once acceptable performance is realized on the simplified environment more complex models will be integrated into the environment.

References

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