Communications and Transport Systems
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Spring 2018

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TNFL03 - fallstudier inom flygtrafik och logistik

Homework Set 3, 03.02.2018

Punctuation and Paragraphs

Solutions will be discussed in the end of lecture # 5.

Exercise 1 (Rewrite the paragraph):
Although the methodological approaches are similar, the questions posed in classic epidemiology and clinical epidemiology are different. In classic epidemiology, epidemiologists pose a question about the etimology of a disease in a population of people. Causal associations are important to identify because, if the causal factor identified can be manipulated or modified, prevention of disease is possible. On the other hand, in clinical epidemiology, clinicians pose a question about the prognosis of a disease in a population of patients. Prognosis can be regarded as a set of outcomes and their associated probabilities following the occurrence of some defining event or diagnosis that can be a symptom, sign, test result or disease.

Exercise 2 (Punctuation):
Check the punctuation in the examples below, rewrite the sentences if necessary.

(a) The British are notoriously bad at learning foreign languages, the Dutch are famously good at it.

(b) Implementation proceeded at a rapid pace for at least a couple of years as so-called liberal bilateral agreements were negotiated with Korea, Thailand, Singapore, Taiwan, Israel, The Netherlands, Belgium and, to a lesser degree, Germany.

(c) Darwin's Origin of Species published in 1859 revolutionized biological thinking.

(d) The flight attendant role revolves around two major responsibilities, safety and service.

(e) Sales in 2005 amounted to $170 billion, broken down as follows: aircraft, $89.1 billion, missiles, $15.3 billion, space-related materials, $37.3 billion, and related products and services, $28.3 billion.

(f) Other important commodities purchased by the aerospace industry include primary, nonferrous metals; for example, copper, aluminum, lead; radio, TV, and communications equipment; and scientific and controlling instruments.

Exercise 3 (Reading):
Please read the text from Figure 1. We will use it in the lecture #6 on February 20.

INTRODUCTION

In deregulated markets, passenger airlines have the freedom to choose flight schedules and prices for routes generated by flight schedules. These decisions are very important for an airline that wishes to maximize its profit. The flight schedule fixes a large fraction of an airline's cost, and also the routes the airline can offer. The schedule determines the quality of the airline's service in terms of departure times and transit durations of routes. Quality of service and prices affect the airline's ability to attract travelers.

This paper studies the competitive choice of flight schedules and route prices by an airline in a hub-and-spoke system. The problem is relevant because many airlines in the United States and Europe provide a substantial fraction of their service using hub-and-spoke systems. Clearly, restricting analysis to hub-and-spoke systems is not always appropriate. Many airlines use a combination of hub-and-spokes and direct routings, and JENG[11] has shown that a mixed system is generally more efficient. However, restriction to a hub-and-spoke system simplifies the analysis, because finding the set of routes generated by a flight schedule is much easier than with other routing patterns. For this reason, the paper restricts itself to hub-and-spoke systems.

This research makes three contributions. First, an expression calculating demand for each route as a function of the service quality and price of all routes is derived. Second, a mathematical programming heuristic is developed to find the flight schedule and route prices that maximize an airline's profit against fixed schedules and prices for other airlines. This heuristic allows an airline to optimize its schedule and prices against competing transportation providers that use any type of schedule, hub-and-spokes-based or not. Third, the heuristic is used to study competition in a hub-and-spoke system by allowing each airline to optimize its schedule and prices against the others' choices and by searching for an equilibrium in schedules and prices.

Demand for routings is derived by aggregating individual travelers' preferences. Following recent models of consumer choice for transit services by MCFADDEN[13, 14] and BEN AKIVA and LERMAN,[2] we assume a random utility model such that each individual traveler's demand is given by a logit function. A traveler's demand for each route is a function of the total cost of using that route. A customer's cost has three components: 1) the cost of departing at a time that differs from the customer's most preferred departure time, or, alternately, the cost of arriving at a time that differs from the most preferred arrival time, 2) the cost associated with the route duration and 3) the actual fare. The total demand for each route is the sum of all travelers' demands for the route.

The profit maximizing heuristic algorithm finds the best flights, routes and prices in a three level hierarchical process. Throughout the paper we use the terms "best" and "optimal" even though our algorithms are heuristic. The third (lowest) level finds optimal route prices that maximize profits. An important assumption made is that airplanes have a finite capacity in seats, which is assumed the same for all airplanes. Route prices are set to maximize the airline's profit subject to this capacity constraint. The second level generates the set of routes considering the flights chosen by the airline. These are the possible routes that can be constructed using the flights. The first (highest) level searches over sets of flights to find the profit maximizing set.

Then, competition between airlines is analyzed by solving for Nash equilibrium flight schedules and route prices for each carrier. At the Nash equilibrium, each airline's flight schedule and route prices maximize its profit against the choices of competitors. For several examples, the set of equilibrium decisions is found.

To simplify the analysis, three assumptions are made. First, there is only one class of customers. Second, planes are assumed to be the same size. Third, no traffic originates or is destined for the hub city. These assumptions are not realistic but are made to reduce the complexity of the problem. It is often assumed that there are at least two different groups of passengers with distinct travel-related costs: business and non-business passengers. If two classes of passengers exist, the algorithm would need to calculate two different prices for each route. This would double the number of price variables and would increase computational time, but not change the model formulation. The presence of two classes of passengers would change the optimal solution, but not the solution methodology. If planes have different sizes, flight scheduling entails choice of flight times and choice of plane types. Although we do not allow mixed fleets, the discussion in Section 4 describes a heuristic that incorporates the fleet mix issue but does not increase problem complexity. The assumption that no passengers begin or end trips at the hub simplified the problem formulation and presentation of the results. Inclusion of these trips would not add to the complexity of the solution procedures described.

The contribution of this research is the integration of competitive scheduling, pricing and consumer choice into one model. Although there have been many papers on airline scheduling, none to our knowledge has studied the interaction of competition, scheduling and pricing issues. The main tool we use is the heuristic algorithm that calculates optimal schedules and prices. We demonstrate that competition can be analyzed for simple examples using the heuristic. An important limitation is that competition is studied only through examples. Clearly, one cannot obtain generalizable insights from the two examples studied. However, by systematically studying more examples, one may find insights about how airlines compete.

This section concludes with a review of the literature. Section 1 describes a model including firm cost, consumer choice and our optimization procedures. Section 2 presents several test problems including performance evaluation against an alternate heuristic. Section 3 models competitive scheduling and pricing in hub-and-spoke systems and presents examples. Section 4 presents extensions, a summary and suggestions for further work.

Figure 1: A text.