Urban transportation networks : equilibrium analysis with mathematical programming methods / Yosef Sheffi

Sheffi, Yosef

Abstrak

The flow pattern throughout an urban network can be looked upon as the result of two competing mechanisms. On the one hand, users of the system (drivers, passengers, pedestrians) try to travel in a way that minimizes the disutility associated with transportation. For example, motorists driving between a given origin and a given destination are likely to choose the route with the shortest travel time. On the other hand, the disutility associated with travel is not fixed but rather depends in part on the usage of the transportation system. Thus, in the previous example, the travel time on each of the paths connecting the origin and the destination is a function of the total traffic flow due to congestion. It is therefore not clear a priori which path through the network has the shortest travel time. Consequently, it may not be obvious
what the flow pattern throughout the network will be under various conditions.
This book describes how this flow pattern can be determined for an urban road network by modeling these two mechanisms (travel decisions and congestion).
The analytical approach described in this text draws on analogies between the two mechanisms mentioned here and the interaction of supply and demand in the marketplace. Instead of analyzing the price of a product and the quantity consumed, the analysis here looks at transportation level of service (or its inverse, travel disutility) and flows. The results of the analysis include a set of flow and a set of level-of-service measures that are at equilibrium with each other.
The book looks at many dimensions of travel choice, including the decision to take a trip, the choice of travel mode, the distribution of trips among various possible destinations, and the choice of route between an origin and a destination. All these decisions, when aggregated and analyzed simultaneously with the congested effects, result in the flow pattern through the network. The analysis of all these travel choices is carried out by using a unified framework that builds on graphical and network representation.
The problem of finding the equilibrium flow pattern over a given urban transportation network is also known as traffic assignment. The basic solution methodology is based on formulating the problem as a nonlinear optimization and solving it as such. This book, however, does not require any prerequisites in mathematical programming or graph theory. All the necessary background is reviewed at an introductory level. The level of mathematics assumed includes college calculus and (in the last parts of the book) introductory probability concepts. The book uses extensively intuitive arguments and network structures, which are utilized to illustrate many situations graphically.