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Route Choice: A Behavioral Analysis and Modeling Approach  

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Abstract—Within the context of transportation modeling, driver route choice is typically captured using mathematical programming approaches. These approaches assume that drivers have close-to-perfect knowledge of the transportation network state in attempting to minimize some objective function. Typically, drivers are assumed to either minimize their travel time (user equilibrium) or minimize the total system travel time (system optimum). Given the dynamic and stochastic nature of the transportation system, the assumption of a driver’s close-to-perfect knowledge is questionable. While it is well documented in psychological sciences that humans tend to minimize their cognitive efforts and follow simple heuristics to reach their decisions, especially under uncertainty and time constraints, and that human perceptions, consequently, are often different from actual reality, in the late stages of typical route choice models drivers are assumed to have close to perfect knowledge of their choice set, as well as the travel characteristics associated with each of the choice elements. In addition, only a few of the many route choice models that are described in the literature are based on observed human behavior. With this in mind this research monitors, analyzes and models actual human route choice behavior based on drivers’ actual experiences, perceptions and choices.

I. BACKGROUND

In an effort to mitigate the impacts of traffic congestion, transportation engineering research is rich in literature directed towards understanding driver travel behavior. Due to the wide application of driver route choice models in the different areas of transportation engineering, where they are classically used in transportation planning models, dynamic traffic assignment models, advanced area-wide signal control models, advanced traveler information system models, among others, driver route choice models probably rank among the most influential models [1, 2]. This PhD research attempts to extend this wealth of research by observing actual drivers route choices and evaluating the interactions between drivers’ experiences, perceptions, cognition trends, choices, and the influence of information.

According to the 2005 American Community Survey conducted by the U.S. Census Bureau, commuters continue to drive their car alone. As a matter of fact, 77 percent of commuters drive to work alone [3] and are the major contributors of traffic congestion with the morning congestion being more severe [4]. Some studies show that most commuters use only one route to get to work or school [5]. On the other hand, other research efforts show that most drivers select more than one route to get to work or school to avoid congestion and minimize travel time. A recent study concluded that 40 percent of the commuters used only one route for their commute and the remaining 60 percent of commuters used at least two routes [6]. Hence, assuming that around half of the drivers use only one route for their commute seems a reasonable assumption.

The cognitive task of route choice is not easy and requires decisions about how to reach a destination while satisfying various limitations and obligations. The number of available alternative routes from an origin to a destination can be vast, and the experience of earlier route choices can affect the probability of the route being selected again. In addition, the characteristics of each alternative route do not have the same importance in a driver’s final decision [6]; how a commuter selects which route to take may be affected by many other factors such as age, gender, driving experience, time, distance, bad weather, and the behavior of other drivers [7].

Most route choice models assume that drivers constantly evaluate and remember their travel times on the routes they travel, and use this information to select the travel route that maximizes some utility function. It assumes that drivers are constantly conscious and rational of their route choice behavior. According to cognition theories, however, human behavior and decisions are highly dependent on humans’ personal perceptions. For example, it is rather common for humans to behave irrationally based on erroneous personal perceptions, or beliefs. In addition, it is well documented in human psychological behavior that humans tend to minimize their cognitive efforts, and follow simple heuristics to reach their decisions, especially under uncertainty and time constraints. In addition, with repetition, cognitive activities become habitual and could reach automaticity. Hence, minimizing the required cognitive resources [8].

Unlike most route choice research that is primarily focused on the end product of the route choice based on rational behavioral assumptions, this research attempts to investigate the validity of these assumptions. It explores the accuracy of drivers’ perceptions and examines the reasons for route choice based on drivers’ perceptions. The authors anticipate that this work will provide insights into driver route choice behavior and that more unexplained variation in modeling driver route choice behavior can be uncovered.

II. MOTIVATION AND OBJECTIVES

This PhD research topic is highly multidisciplinary, incorporating theories from several fields of science: transportation engineering, systems engineering, human
factors, human-computer interaction, psychology, business, economics, virtual reality, and artificial intelligence. The research point is primarily focused on investigating the extent of validity of the core assumptions embedded within state of the art drivers’ route choice models currently used in transportation planning and traffic engineering software. State of the art route choice models assume drivers’ either perfect or close to perfect knowledge of their alternative routes choice set as well as traffic conditions, and dependent travel times, on each one of these alternatives. Coming from the science of economics, these theories have been introduced and continued evolving within the Transportation Engineering science for more than half a century now. The core assumptions of rational human behavior, however, remained largely unchallenged.

Recent findings in human psychology have been repeatedly proving that human decisions and behaviors are frequently driven by subconscious perceptions that are not rational. Furthermore, when faced with time constraints, humans tend to behave irrationally. This research is planned to use state of the art human psychology decision theories to investigate driver route perceptions, resulting choices, and involved rationality. With the conclusion of this research the following four questions would be answered: a) are drivers capable of identifying minimum travel time routes?; b) do drivers always consciously evaluate travel times on all alternative routes, then chose to travel on the route characterized with minimum perceived travel time?; c) from a network performance standpoint, how do the results based on current state-of-art route choice models compare to a cognitive-based route choice model?; and d) how would the provision of information alter drivers’ route choices? As a side track to the main research, this work investigates the suitability of using simple and immersed virtual reality simulators to model drivers’ route choice behavior.

III. METHODOLOGY

This PhD research is planned on three stages: first, a pilot study using a simple STISIM driving simulator; second, an immersed virtual-reality driving simulator experiment; and third, a field experiment on the actual road network; in the real, uncontrolled environment. As a side track to the main research, with the objective of investigating the suitability of using simple and immersed virtual reality simulators to model drivers’ behavior, comparison between the results of the simple and immersed virtual reality simulator environments will be compared against those of the field experiment. It is worth mentioning that the first part of the research is almost complete. Initial results, along with recent human psychology findings, suggest significant differences between drivers’ experiences, perceptions and route choices. Hopefully, this research will positively affect route choice models used in transportation planning, traffic engineering software, and route guidance systems.

IV. CURRENT FINDINGS

Following is a short discussion of the findings and implications of the initial experiment. It should be noted that although these findings are not conclusive, they seem very promising.

(a) Drivers perceptions are significantly different from the actual experiences, and drivers’ choices are better explained by their perceptions than their experiences.

(b) Drivers can perceive travel speeds better than travel times. Although, driver travel time perceptions can reasonably explain their route choices, perceived travel speeds seem to influence route choice more than perceived travel times.

(c) Although there appears to be possible evidence to conclude that drivers learn network conditions by experience, it appears that drivers perceptions over estimate the benefits.

(d) Soliciting drivers’ route choice based on observing choices over a period of time with reasonable accuracy is possible.

(e) Drivers’ route choice behavior differs across different driver demographic groups.

(f) Four different driver cognition and learning evolution patters were identified.

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REFERENCES


