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Triangular intuitionistic fuzzy number theory for driver-pedestrians interactions and risk exposure modeling

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Abstract

We travel every day as pedestrians on the road network, if only for a short time, in order to reach another means of transport. But this activity is not as risk-free as it should be. These accidents represent the product of an overall system combining the individual behaviors of pedestrians and drivers, transport activity, and the environmental system, under conditions that make these malfunctions both predictable and avoidable. This predictive skill is an essential step in ensuring the safety of pedestrians in road traffic. In this paper, we use intuitionistic fuzzy number theory in order to model the exposure of pedestrians to the accidents risks by new indicators. This approach aligns the behavioral psychology of pedestrians and drivers with intuitive methods based on the theory of fuzzy sets. A software solution is developed for this instance by reusing the models of pedestrian simulation developed in our previous works. The attempt in this article considers a novelty in partial aspect of risk modeling. The fuzzy intuitionistic theory has the flexibility to investigate hesitation and indecision. Some other behavioral and environmental factors must be taken into account in order to explore deeply the issue.

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*Keywords:*Intuitionistic fuzy number, virtual pedestrian model; intelligent agent; simulation; accident risk; transportation theory

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1. Introduction and backgroud

How does the code road define a pedestrian? If the most common use of the pedestrian term is to characterize the "person who walks on foot (in town, on a road)", the road code rakes wider. Pedestrians are also persons who drive a child, sick or infirm car or any other small vehicle without a motor. Moreover pedestrians are also considered as persons who drive a cycle or a moped by hand, the infirm who move in a wheelchair driven by themselves or moving at the walking pace. According to the World Health Organization, every year nearly 1.25 million people die in a road accident and 20 to 50 million are injured, sometimes even handicapped. The majority of these victims are pedestrians hit by motor vehicles in various situations. Road traffic injuries result in considerable economic losses for those affected, their families and countries as a whole. There are few global estimates of the cost of road accidents, but studies conducted in 2010 show that they account for about 3% of national gross product. This number even reaches 5% in some low- and middle-income countries. Pedestrians are at risk of accidents either by standing or walking on the sidewalk or crossing the road. The number of accidents depends on the local transport policy and the resources devoted to pedestrian safety. It should be noted that there is a close relationship between pedestrian safety and their environment. The design of streets rests on the specific characteristics of cars, namely their speeds, dimensions, the spaces required for rotating movements, and so on. Without taking into account those of pedestrians, which increases the risk of pedestrian accidents. This is because walking is not yet considered as an essential and necessary part of the overall transport system. Although, in recent years, streets and areas dedicated to pedestrians, "zones 30" and restricted traffic have been developed, but this approach is still limited, due to divergence between the design of the planner And that of the user, which leads to dysfunctions observed in the system failures in the form of accidents. These dysfunctions are both predictable and avoidable as they represent the product of an overall system combining the individual behavior of pedestrians and drivers, transport activity and the environmental system. The reduction or elimination of risk to pedestrians is an important and achievable goal. This risk is greater for children, the elderly and pedestrians who are intoxicated because of their inability to adapt to both the reflexes of road traffic and the rules governing interaction with the road environment. From an early age, men transgress these rules and are more likely than women to be involved in a road accident. Almost three-quarters (73%) of the victims killed on the roads are men. In young drivers, young men under the age of 25 are nearly three times more likely to be killed in a car accident than young women. This can be explained by the fact that women are more susceptible to potential losses, while men are compared to earnings. This behavioral difference results from the dissimilarity of the sex roles of the stereotypes to which they belong. These roles are defined culturally and strongly influence the belonging of the individuals to these stereotypes, without of course neglecting the possibility of adherence to the stereotypes of the opposite sex. On the other hand, it should be noted that the factor of adherence to sexual stereotypes constitutes the best predictor of risk taking by referring to both the age and sex of the individual concerned, whether pedestrian or driver. In our study, we assume that pedestrians are only at risk when crossing a road, as accidents outside the crossing area are generally rare. This crossing can take several forms of routes involving different types of crossing depending on the characteristics of the road traffic, including volume and traffic speed. Thus crossing pedestrians can be perceived as one between the characteristics of road traffic, adherence to sexual stereotypes and the desire to carry out this activity with maximum possible comfort.

Why fuzzy intuitionistic risk? The study of the exposure of pedestrians to the risks of accidents is based mainly on relevant kinematic parameters of the vehicle and the pedestrian and certain geometric criteria of the road. And this without taking into consideration the behavioral factors related to the perception of space and the decision-making of the two road users. To overcome this problem, the intuitionist approach makes it possible to relate the two realities perceived by the two users, taking into consideration both the objective and subjective information of the driver and the pedestrian. On the one hand, we have integrated the two antagonistic perceptions into intuitionistic fuzzy numbers and, on the other hand, developed a relative ranking method to derive the indicators of risk exposure.

The remainder of this paper is organized as follows: section 2 recalls our fuzzy ant pedestrians' model and situates it in relation with Pedestrians' risk accident exposure. The section 3 introduces intuitionistic fuzzy theory and gives first concepts for risk exposure modeling. Finally, section 4 concludes.