# ATSS Workshop Programme

(09:00–10:30) **Agents in ATS I**

- (09:00-09:10) *Opening session*
- (09:10-09:30) M. Abbas, L. Chong, A. Medina, Virginia Tech, USA, "Neural-Agent Driver Behavior Modeling Using Naturalistic Data"
- (09:30-09:50) J.-P. Barthès, P. Bonnifait, UT Compiègne, France, "Multi-Agent Active Interaction with Driving Assistance Systems"
- (09:50-10:10) R. Claes, T. Holvoet, J. Van Gompel, KU Leuven, Belgium, "Coordination in Hierarchical Pickup and Delivery Problems Using Delegate Multi-Agent Systems"
- (10:10-10:30) J. Holmgren, L. Ramstedt, P. Davidsson, Blekinge Institute of Technology, Sweden, "Roles and Responsibilities in Supply Chains: an agent simulation modeling framework"

(10:30–11:00) Coffee Break

(11:00–12:20) **Agents in ATS II**

- (11:00-11:20) Neme, S. Hernández, O. Neme, UA México, México, "A Multi-Agent Model of the Users Internal Displacement Dynamics and their Distribution in a Large-Capacity Bus"
- (11:20-11:40) M. Netto, B. Neto, C. Lucena, PUC-Rio, Brazil, "A Pattern-based Framework for Building Self-Organizing Multi-Agent Systems"
- (11:40-12:00) F. Aguiar, R. Rossetti, E. Oliveira, U. Porto, FEUP, Portugal, "MAS-based Crowd Simulation Applied to Emergency and Evacuation Scenarios"
- (12:00-12:20) Bazzan, M. Amarante, T. Sommer, A. Benavides, UFRGS, Brazil, "ITSUMO: an Agent-Based Simulator for ITS Applications"

(12:20–14:00) Break (Lunch not provided)

(14:00–14:50) **Keynote Lecture K1**

- Ronghui Liu, ITS, U. Leeds, UK, "The Role of Microscopic Simulation in ATS"

# A multi-agent model of the users internal displacement dynamics and their distribution in a large-capacity bus

Antonio Neme, Sergio Hernández, Omar Neme

*Abstract*— **High-capacity buses are common in public transportation systems. The dynamics and distribution observed by users inside the bus are not trivial and in some cases, as those observed in the Mexico City public transport system named Metrobus, those dynamics lead to user distributions in which several areas present a very low density and areas located close to the entrances and exits exhibit a very high density of users. This dissimilarity in density is inconvenient for a number of reasons, as the capacity of the bus is not achieved because of improper distributions, and discomfort of users is high. Through an agent-based model, we study the agents dynamics and their interactions between them and the bus structure. We lead to the conclusion that even when users tend to move to a region in which they perceive low density of occupation, if some agents try to maintain their position close to the exit door, odd distributions are achieved. To find better policies, we tested some alternatives for users to enter and exit the bus. We found that it is possible to have a better density distribution and a better comfort if entrance and exit doors are not differentiated at all.**

## I. Introduction

Since the seminal work of Helbing et al [1], the behavior of pedestrians has been subject of study from the traffic modelers community, and in particular, from the agent-based models perspective. The behavior and dynamics of pedestrians are not trivial to model and in many cases, they are more complex than the dynamics shown by vehicular traffic, as the constrains of lanes and directions of the flow are not present [2], [3].

Several aspects of pedestrian dynamics have been studied, including crosses, routing [4], free flow, and behavior under panic [1].

A special case of pedestrian traffic is that in confined spaces, such as in galleries or in malls [5]. In these cases, pedestrians follows a path based in both, the collection distributions (or stores) and the density of other pedestrians [6]. From the confined space case, there is one in particular that is of high impact in the daily life: the pedestrian dynamics in the high-capacity city buses.

The city buses in some cities are normally large enough as to contain as much as 200 passengers, some standing and some seated. Normally, the journey is limited to the city limits, and the time necessary to cover the whole route may vary from few minutes to a couple of hours. Normally, passengers do not travel all the journey, and there is an exchange of passengers in all intermediate stations [7]. These exchange leads to non-trivial dynamics, as some passengers tend to move to more comfortable areas, while others tend to stay in areas close to the exit.

In some high-capacity buses, the behavior of users may be affected by physical constrains such as seat distribution, entrances, exits, and handrails. Also, the overall dynamics observed in the bus is affected by the strategies followed by users in order to find a seat or a more comfortable position. We are interested in the dynamics followed by passengers in a high-capacity bus, in particular, that observed in the *Metrobus* public transport system in Mexico City.

In the mentioned buses, users tend to stay close to the entrance/exit facility, apparently with independence of both, the journey duration, and if there are plenty of available space in other areas. This situation leads to odd passenger density in the bus, as some areas are not visited by passengers, while other areas, mainly those in the exit neighborhood are very dense.

There are a number of explanations to this behavior. Most of them are only observational and lack of a quantification of these phenomena. One common explanation is that passengers know the bus will achieve the maximum capacity and moving around in that situation to get to the exit is not an easy task [8], [16].

Agent-based models are a proper tool to study pedestrian traffic, as they keep a complete record of behavior, visited locations and any other variable, at the time that agent may adapt their behavior [8].

In the actual scheme, users are divided by genre, so men and women enter the bus in differentiated doors. Both men and women may exit through any door. Our hypothesis is that this is not the optimum scheme in the sense of homogeneous distribution. Rather, we give evidence from simulations that if the entrance door were differentiated from exit doors then the distribution of users in the bus tends to be less biased and some measures of comfort are higher.

Here, we propose a microscopic model of pedestrians interactions. The problem we are trying to study is that of heterogeneous distribution of users in the bus, as a measure of the quality of the trip from the perspective of users. Pedestrian dynamics is closely related to this phenomena. There are three main perspectives of study of pedestrian dynamics. The first one is continuum dynamics, in which pedestrians are seen as a fluid and physical rules defined as social forces

Research project supported by ICyTDF.

A.N. is at the Non-Linear Dynamics and Complex Systems Group, Universidad Autónoma de la Ciudad de México, México, D.F. neme@nolineal.org.mx.

S.H. is a posgrade student at the Master in Non-linear Dynamics and Complex Systems Group, Universidad Autónoma de la Ciudad de México cheko@ciencias.unam.mx.

O.N. is a researcher at the Postgraduate and Research Study Section. Superior School of Economics. Instituto Politécnico Nacional. México. oneme@ipn.mx.