How do participants act during an apéro at ETH

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1 Introduction

There are many conferences, seminars and talks occur at ETH. They usually have a coffee break or apéro afterwards. Many people leave the lecture hall and go towards the bouffe table at the same time. After having their coffee and food, they try to find empty tables to eat and drink. If there were not many people but only one person, his/her behavior can easily be expected such that following the shortest path to bouffe table and to the nearest table. However, when many people have similar destinations, their behavior would affect each other and it is not straight forward to expect how they behave. Our problem is to see how people behave during an apéro after a talk at ETH main building as in Figure 1.

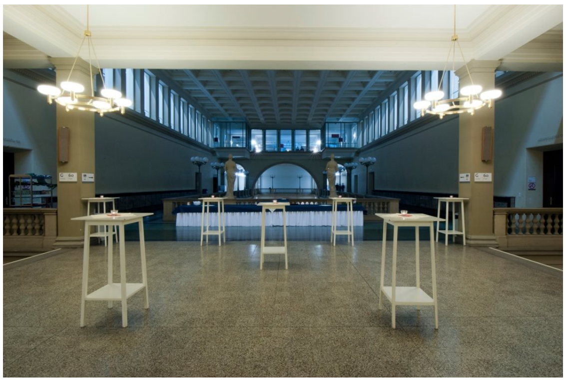

Figure 1: Apéro

2 Model

The problem can be represented by the Social force model[1] for pedestrian dynamics. During the apéro, the pedestrians' motion can be described as if they were subjected to social forces that are a measure of personal motivations of the individuals to perform certain actions. These forces have to represent and take into account the effect of the specific environment, which includes:

- The points that the pedestrians have to reach in order to collect the food from the apéro table;
- The distribution around a table after collecting the food;
- The tendency to keep a certain distance from other pedestrians and borders represented by the obstacles in the apéro area.

The desired direction of motion of a pedestrian can be described by the following formula:

$$\vec{e}_\alpha(t) := \frac{\vec{r}^{\,k}_\alpha - \vec{r}_\alpha(t)}{\|\vec{r}^{\,k}_\alpha - \vec{r}_\alpha(t)\|} \tag{1}$$

where $\vec{r}^{\,k}_\alpha$ represents the next destination to reach and $\vec{r}_\alpha(t)$ denotes the actual position of pedestrian α at time t.

The equation of motion of the pedestrian α is given by:

$$\frac{d\vec{r}_\alpha}{dt} = \vec{v}_\alpha(t) \tag{2}$$

while the acceleration equation of the pedestrian α is given by:

$$\underbrace{\frac{dv_\alpha}{dt}}_{\text{acceleration}} = \underbrace{\frac{1}{\tau_\alpha}(v_\alpha^0 e_\alpha^0 - v_\alpha)}_{\text{driving force}} + \underbrace{\sum_{\beta(\neq\alpha)} \mathbf{F}_{\alpha\beta}^{int}}_{\text{interactions}} + \underbrace{\mathbf{F}_\alpha^{\text{walls}}}_{\text{boundaries}} \tag{3}$$

where the driving force is given by the destinations to be reached during the apéro, the interactions are represented by the influence of other pedestrians and the boundaries are the obstacles and the walls in the apéro area.

Because our problem is about simulating the actions and interactions of individuals, we are going to use Agent-based modeling to solve the problem stated.

3 Research Objective

Questions that we want to answer are

- How does the number of people affect their behavior?
- How does the number of items to be taken from the bouffe table, affects the behavior of the people?
- What happens when people exit from several doors from the lecture hall?
- How does the number and distribution of the tables affect the dynamics of the people?

4 Literature

Our project is mainly based on the model developed by Dirk Helbing and Péter Molnár in *Social force model for pedestrian dynamics*[1]. We will also consider the model modifications made by Taras I. Lakoba, D. J. Kaup and Neal M. Finkelstein in *Modifications of the Helbing-Molnár-Farkas-Vicsek Social Force Model for Pedestrian Evolution*[2]. It is worth reporting that the inspiration for the topic partially comes from the work done by M. Vifian, M.Roggo, and M. Aebli about the queue formation in the ETH-Polymensa.

References

[1] D. Helbing, L. Buzna, A. Johansson, and T. Werner. Self-organized pedestrian crowd dynamics: Experiments, simulations, and design solutions. *Transportation Science*, 39(1):1–24, 2005.

[2] Taras I. Lakoba, D. J. Kaup, and Neal M. Finkelstein. Modifications of the helbing-molnár-farkas-vicsek social force model for pedestrian evolution. *Simulation*, 81(5):339–352, 2016.