%add picture

source:kestrel-cam

Lecture with Computer Exercises: Modelling and Simulating Social Systems with MATLAB
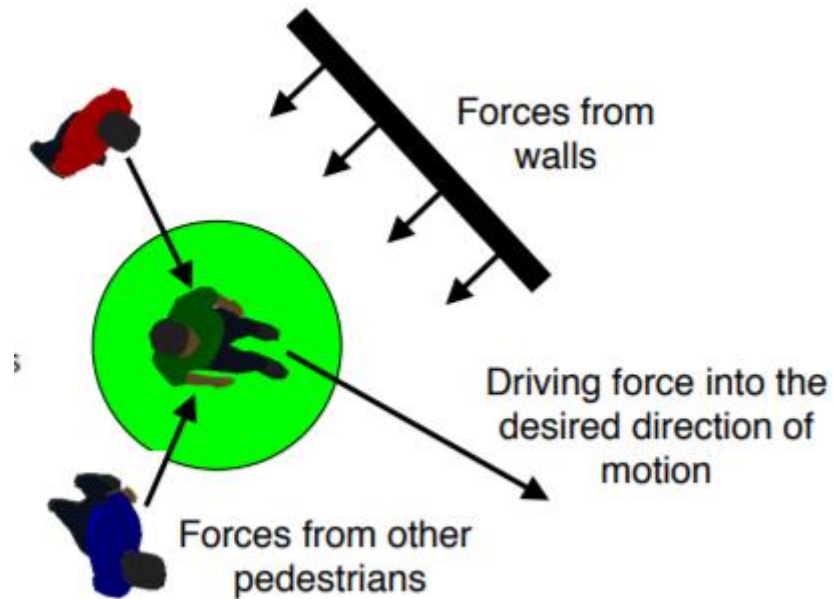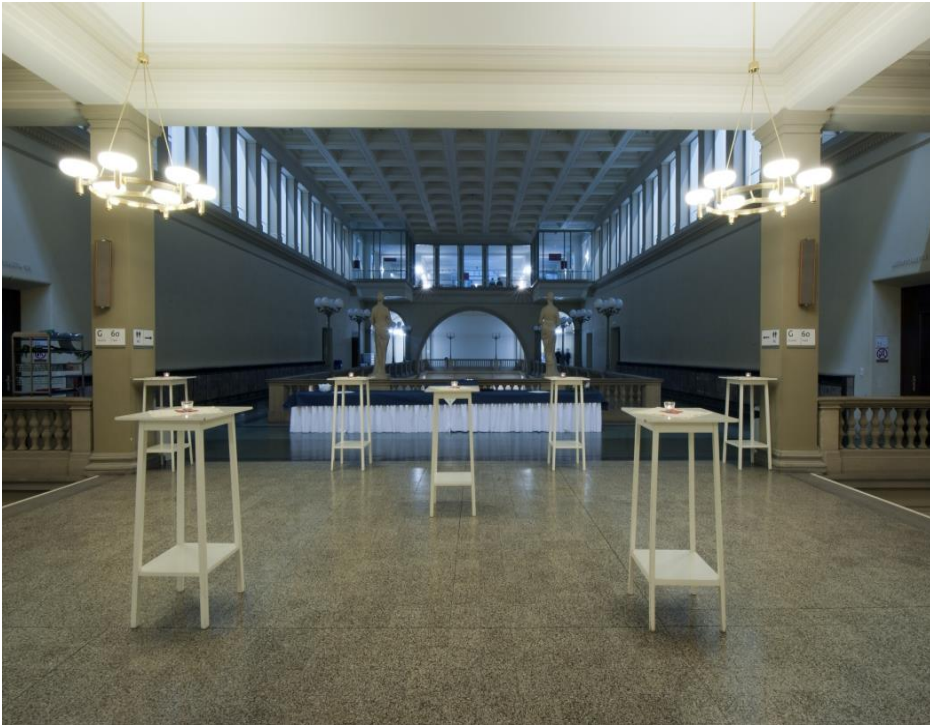
How do participants act during an apéro at ETH?

Emek Barış Küçüktabak, Francesca Sabena, Emile Courthoud, Hangxi Li

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- Description of the Model

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Introduction and Motivation

Social Force Model

Forces from walls

Driving force into the desired direction of motion

Forces from other pedestrians

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

Introduction and Motivation

How does the number of
- o People
- o Food / drinks
- o Tables (and their disposition)
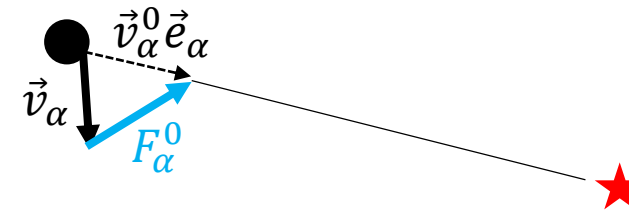
affect the behavior of the participants ?

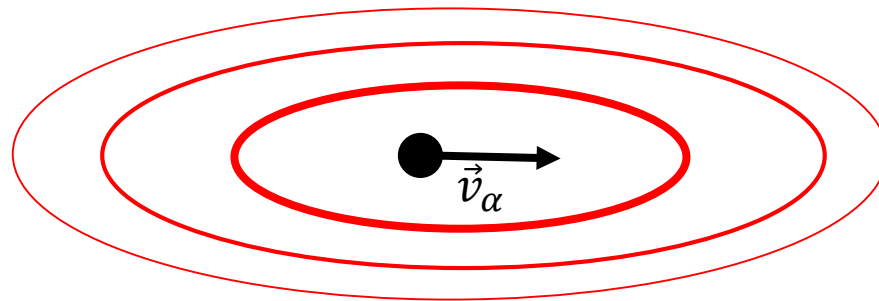# Description of the Model

- ## Force due to Destination

  - ➤ Considering a pedestrian alfa:

  $$F_\alpha^0(\vec{v}_\alpha, \vec{v}_\alpha^0 \vec{e}_\alpha) := \frac{1}{\tau}(\vec{v}_\alpha^0 \vec{e}_\alpha - \vec{v}_\alpha)$$

- ## Force due to other pedestrians

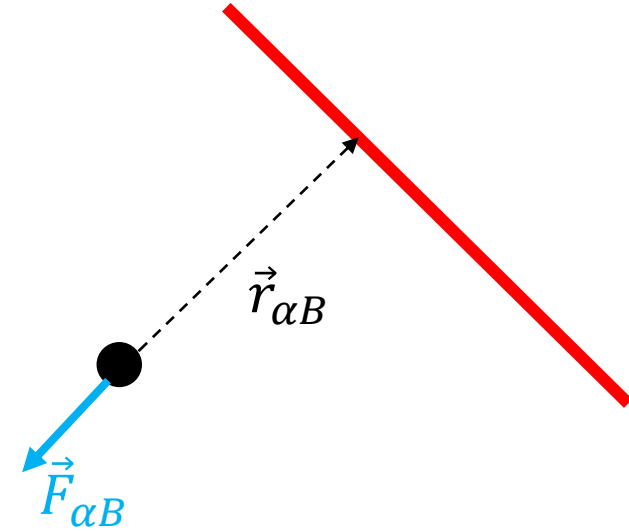 - ➤ Monotonic decreasing force field with elliptical shape

$$\vec{f}_{\alpha\beta} := -w\nabla_{\vec{r}_{\alpha\beta}} V_{\alpha\beta}[b(\vec{r}_{\alpha\beta})] \qquad \text{with} \qquad 2b := \sqrt{(\|\vec{r}_{\alpha\beta}\| + \|\vec{r}_{\alpha\beta} - v_\beta\Delta t\vec{e}_\beta\|)^2 - (v_\beta\Delta t)^2}$$

Description of the Model

- Force due to obstacles and walls

  ➢ Monotonically decreasing force field

$$\vec{F}_{\alpha B} := -\nabla_{\vec{r}_{\alpha B}} U_{\alpha B}(\|\vec{r}_{\alpha B}\|)$$

- Total Force

  ➢ Summation of all forces

$$\vec{F}_{\alpha}(t) := F_{\alpha}^{0}(\vec{v}_{\alpha}, \vec{v}_{\alpha}^{0}\vec{e}_{\alpha}) + \sum_{\beta} \vec{f}_{\alpha\beta} + \sum_{B} \vec{F}_{\alpha B}$$

Implementation

- Person-Person repulsion

  - Exponentially decreasing potential

  $$V_{\alpha\beta}^{0} e^{b/\sigma}$$

  - Force multiplied by different coefficients considering the relative position of the people

- Table-Person repulsion

  - The tables are obstacles while the people are directed to the food.
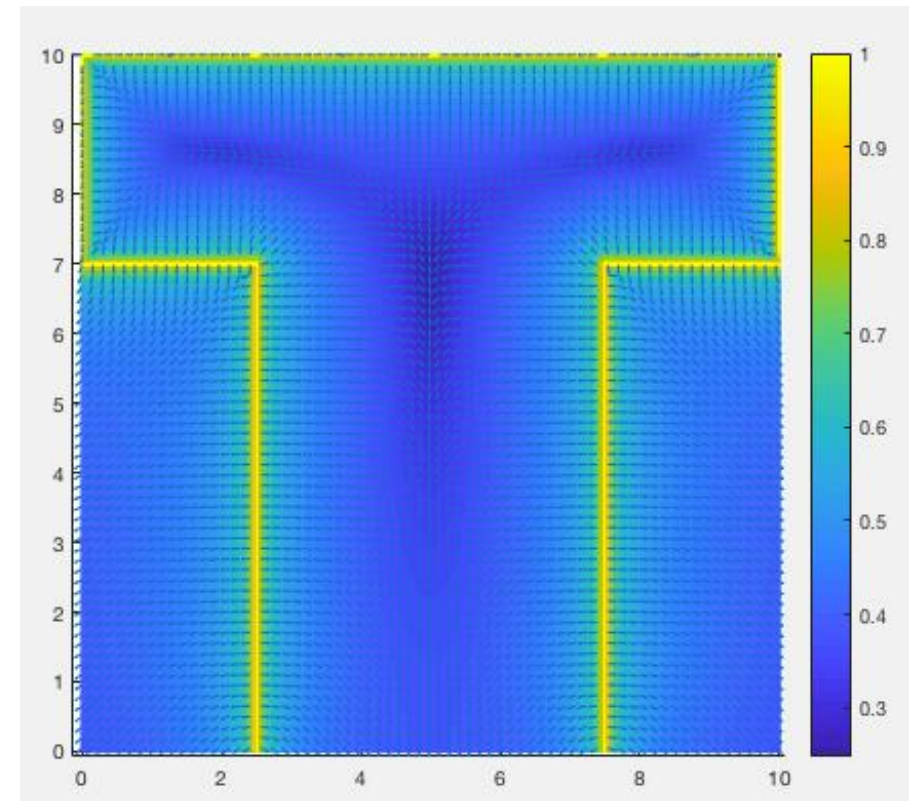
    Table-person constant Ct=0.05

Implementation

- ## Wall-Person repulsion
    - ➤ Total repulsion force is equal to the superposition of all the point source contribution:

$$F_{wall-person} = \sum_i^N \frac{k}{D_{p-w,i}}$$

    - ➤ Discretization of the Apéro room into a rectangular mesh of points

Implementation

- ## Path towards the objective

  - ➢ Pedestrian follows the shortest polygonal route
  - ➢ 1st objective: Apéro table
  - ➢ 2nd objective: nearest table in the Apéro room

- ## Destination change

```
if person has taken the food
        Sort the tables with respect to their distance to the person
        for i in sorted tables
                x = number of people going towards to ith table
                if x < table capacity of ith table
                set destination of person as the ith table
                break;
                end if
        end for
end if
```

Simulation

- 3 functions are used to consider the cost of every simulations:

  - ➢ Time cost function
  - ➢ Velocity cost function
  - ➢ Force cost function

- Simulation conducted by averaging different simulations over 20 attemps each.
  The parameters that changed are:

  - ➢ Number of participants
  - ➢ Number of tables
  - ➢ Disposition of tables (circular or rectangular)
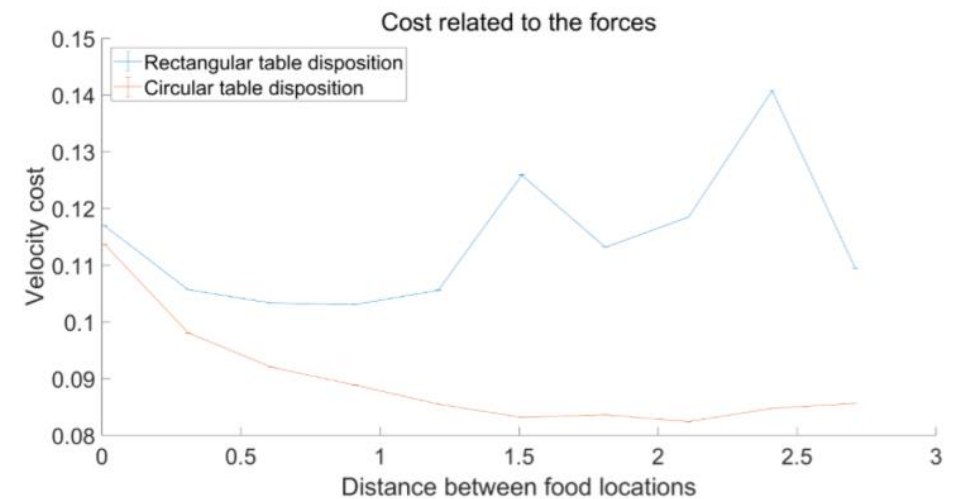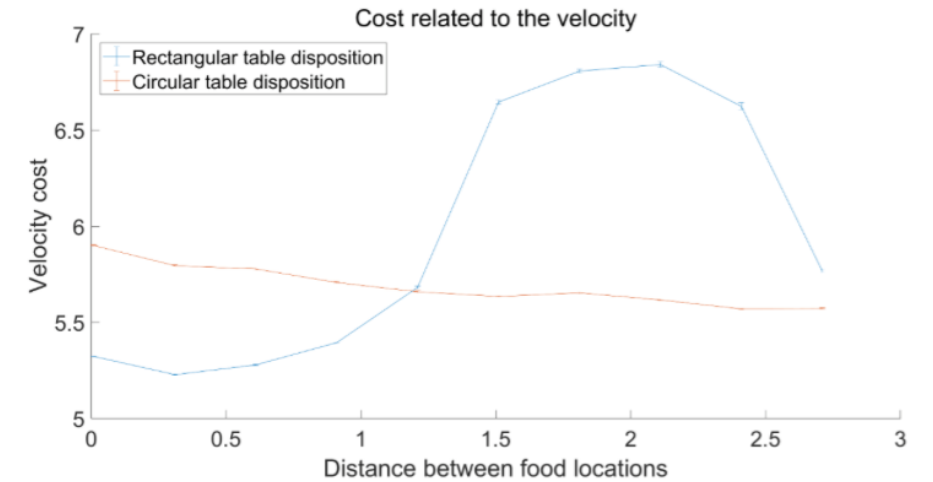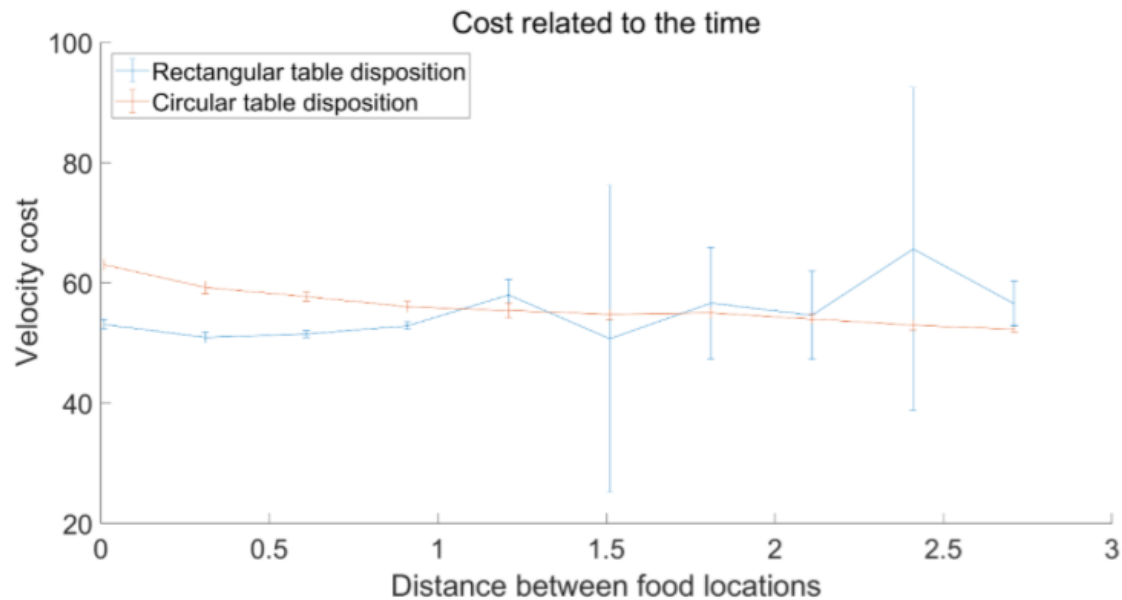 - ➢ Distance between food positions on the buffet table

Simulation

- Changing the number of participants
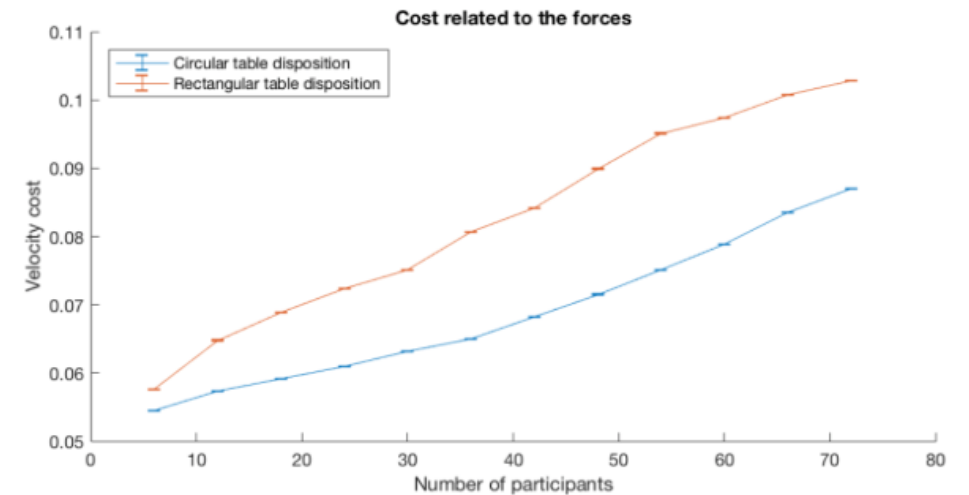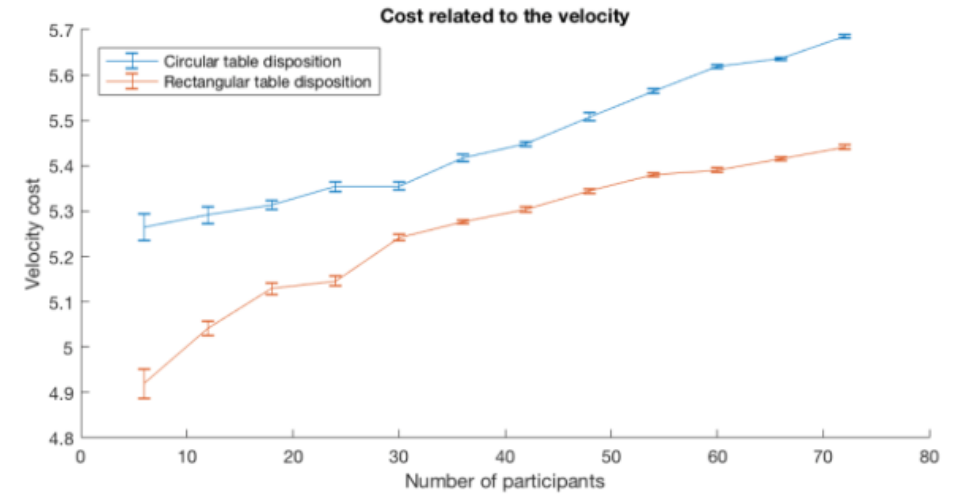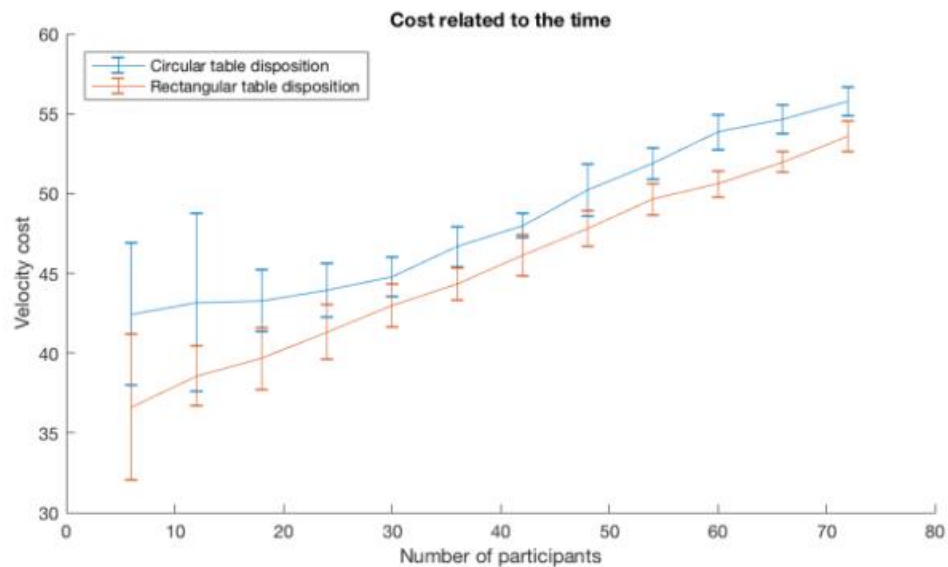
Simulation

- Changing the food positions

Results and discussion

%write something about final results and what configuration is better ecc…
%Add videos

Thank you