Description: ETHlogo

**Lecture with Computer Exercises:**

**Modelling and Simulating Social Systems with MATLAB**

Project Report

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| Newspaper boxes: How do they influence the pedestrian flow? |

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Declaration of Originality

Hey Leute, kann das jemand öffnen, bei mir geht’s irgendwie nicht… ☹ (<http://www.soms.ethz.ch/teaching/MatlabFall2012/confirmation_en.pdf>)

Agreement for free-download

We hereby agree to make our source code of this project freely available for download from the web pages of the SOMS chair. Furthermore, we assure that all source code is written by ourselves and is not violating any copyright restrictions.

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1. Abstract

…..

In order to enhance the readability of this text, we used ‘he’ as a personal pronoun. However, male and female persons are meant equally.

1. Individual contributions

In the beginning, ideas for our projects and on how to implement the simulation were discussed together. The code was written by Dario Kneubühler, Roman Müller and Ueli Wechsler with the following general contributions: ….??? Simulations and analysis were executed by …??? The report was written by …???.

1. Introduction and Motivations

Every day many people pass through Lucerne train station and several simulation programs were implemented to study the interaction between geometry of the building and the passenger's flow (Emch+Berger AG Bern). With the emergence of free newspapers (like "20 Minuten", "Blick am Abend") about 10 years ago, this problem got a new dimension: If a commuter is heading towards the newspapers box, he often has to cross the other people's flow.

In rush hours this can strongly influence the general passenger flow when entering or leaving the platform and the station. How much can such boxes slow down pedestrians? Where are their best locations, such that all pedestrians (including those who are picking up a newspaper) can pass the train station as fluently as possible?

* 1. Fundamental Question

Based on these reflections, we phrased our research question: How do different newspaper box placements influence the time, in which the pedestrians pass a certain route.

* 1. Research Methods

We used the layout of Lucerne train station. In order to find the ideal arrangement of a newspaper box, we manipulated its location and ran several simulations.

((We will choose several different positions, run the simulations and then visually select the two most diverse options.?? Wei mer das immer no so machä??))

For the different simulations, we evaluated the time a person a person needs to get from one entry line to another exit line. We as well investigated the influence of several initial parameters (pedestrians velocity, number of pedestrians, required time to pick up a newspaper, number of paper-takers, …???)

The final output let us conclude, how strongly an unfavourable placement of newspaper boxes influences the pedestrian flow.

* 1. Expected Results

We expected to get both a significant and a relevant difference between the placement options. Furthermore, we expected that a box positioned in the middle of a corridor (compared to a box standing at the edge) will slow down the passenger's flow if the number of paper-takers is low, but might be preferred if a high ratio of passengers is taking a newspaper, because a smaller part of the pedestrian flow has to be crossed to pick up a newspaper. Also, people picking up a newspaper can form a crowd, which can lead to a bottleneck situation if the percentage of paper-takers is high.

Picture of many people arount a Paperbox

(Dario)

Figure 1:

1. Description of the Model

Our Goal was to implement the pedestrian simulation model that is best suited for our research purpose. We decided to use the social force model since it is easy to adapt and was used with success for similar projects.

The model describes pedestrians as particles that are driven by forces. Our implementation is based on the paper “Social Force model for pedestrian dynamics” by Helbing et al.

* 1. Destination Force

Each pedestrian aims to reach a certain destination. They will most likely choose the shortest possible path, which usually is of the shape of a polygon. This polygon is given by

where is the next edge of the polygon and the current position of the agent.

Taking into account the pedestrians current and desired speed results in the Force F’ that points in the pedestrians desired direction.

In order to solve this problem we used a version of the fast marching algorithm. It calculates the gradient field of the shortest path for all 6 possible desired destinations (five exits and the paperbox).

* 1. Pedestrian Force

This is the force that controls the interactions between pedestrians. Pedestrians like to have a zone of privacy around them. The closer they get to a stranger the more uncomfortable they feel. Also actions that happen in front of the pedestrians will affect them more than actions that occur behind them. This is taken in the account by a sphere of privacy around each pedestrian which has the form of an ellipse pointing into the direction of his velocity. F’’ is the repulsive force of a pedestrian, where v is the potential field surrounding each agent and is the distance between the pedestrians i and j.

* 1. Wall Force

Agents are repulsed by walls and other obstacles that might be in their way. Therefore every wall is surrounded by a potential field that leads to a force F’’’ which can be described by

where is the potential of the wall and is the distance between the wall and the pedestrian. The repulsive force gets exponentially bigger the closer the agent gets to the wall, thereby avoiding that agents bump into walls or get stuck.

* 1. Total Force

Superpositioning the three Forces results in the total Force given by

* 1. Polygon -🡪 Implemantation

To define the agents path to their goal a first approach was made by implementing our own code. The general idea was to look at the line between the agent and its final destination. If there were any walls between them the destination was changed to a secondary destination being on the corner of the obstacle which leads to the shortest path to the final destination. These steps were repeated for any obstacles that might be in the agent’s way.

After some time we realized that implementing our own code for this problem would take up too much time and we decided to use the fast marching algorithm instead which was used with success in similar projects.

* 1. Fast Marching Algorithm -🡪 Implementation

The fast marching Algorithm is based on the Eikonal equation. It is numerical method of solving the shortest path problem. In our project it was used to calculate the gradient fields for the destination forces

It creates a gradient that shows the shortest distance to every point on the map from a given starting point. If we assume constant velocity this is equal to traveltime.

(Bild der Gradientenkarte)

1. Implementation

Initialisiation

Save Data

Agents Loop

Time Loop

Update

Figure 2: Stimmt das so???

Init: Bild einlesen, importing station model (Ueli), 6 versch. Ausgänge, jedem Fussgänger wird je ein Eingang und ein Ausgang zugewiesen mit best. Wahrscheinlichkeit

Interaction between agents (Roman)

1. Simulation Results and Discussion
2. Summary and Outlook
3. References

Helbing, D., Molnar, P. (1995). Social Force Model for Pedestrians Dynamics. Physical Review E, 51(5), 4282-4286.

Emch+Berger AG Bern. Simulation Fussgängerströme SBB Bahnhof Luzern. Retrieved 21. November 2012, from Emch+Berger AG Bern Web Site: http://www.bern.emchberger.ch/referenzen/1\_13\_move/simulation\_fussgaengerstroeme\_sbb\_bahnhof\_luzern

1. Research plan
2. MATLAB program code