Analysis of Pedestrian Motion Using Voronoi Diagrams in Complex Geometries

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Context

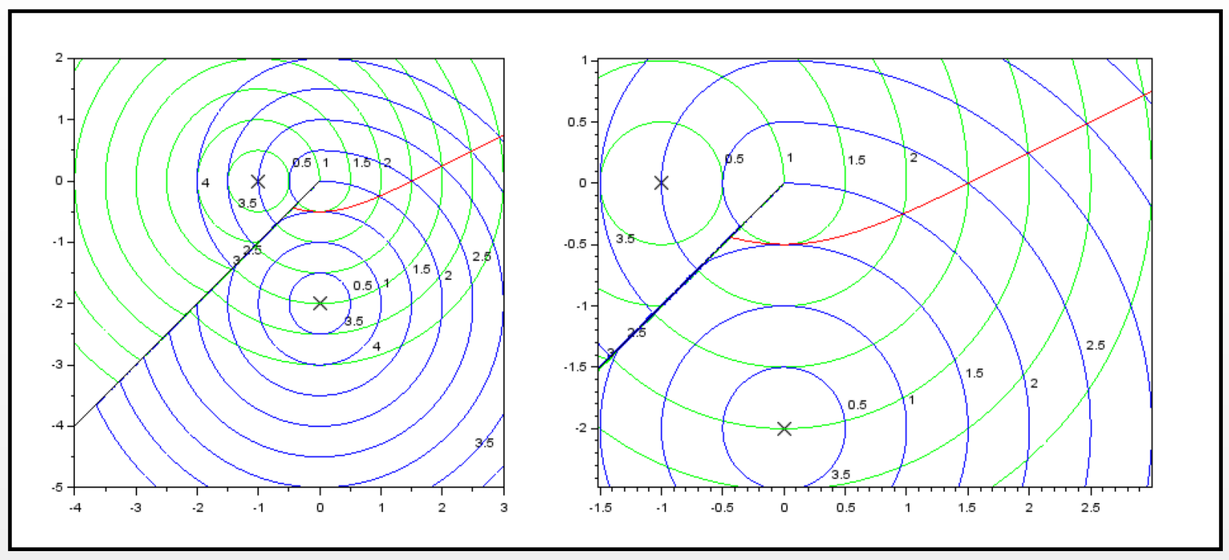
- **Voronoi diagrams** are an established method in the analysis of pedestrian motion for constructing a density from 2D positions
- Used to give **point-wise values** for flow, speed etc.
- Method first described for high-density situations in a simple geometry and **without considering the influence of walls**
- The distance between points in the presence of obstacles should not be the standard Euclidian distance, but the length of the **shortest path**

Objectives

- In this work, we now give details of how to extend Voronoi diagrams to make it fit for the **presence of walls and obstacles**
- We also show how the size of a personal space restricted for persons at the edge of a group by using **dynamical cut-off**
- Based on these modifications, having point-wise values for quantities of interest allows to give average values **for arbitrary geometries**
- To be useful, different quantities may need **different kind of averages**, arithmetic or harmonic, weighted with density etc.

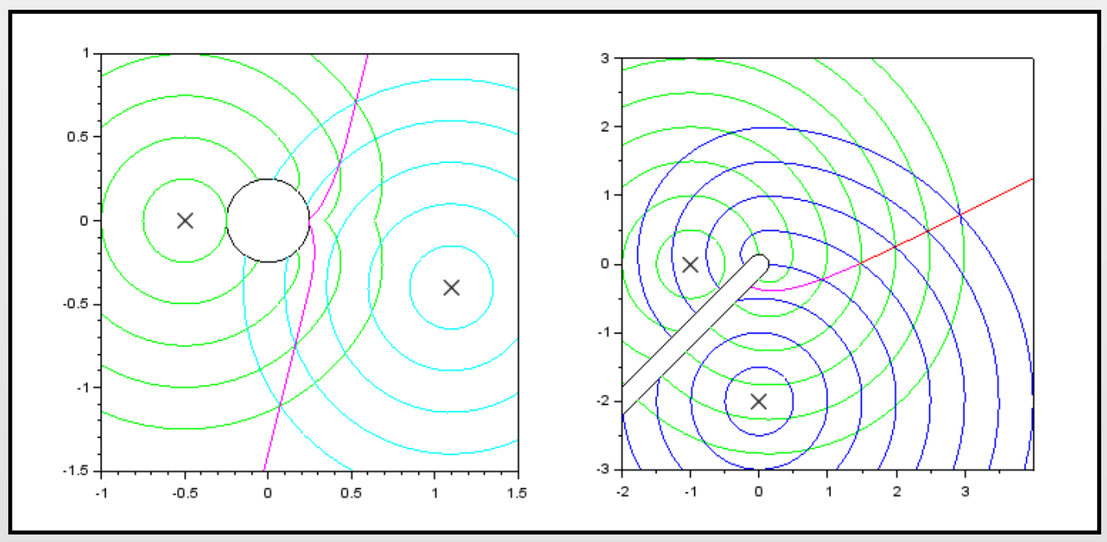
Example 1

- 2 persons at $(-1, 0)$ and $(0, -2)$ with a wall from $(0, 0)$ to $(-5, -5)$
- Classical dividing line only correct for $y \geq 0$ (above the end of the wall)
- For $y \leq 0$ separation given by the hyperbola $x = \sqrt{3y^2 + 6y + 2.25}$



Example 2

- More complicated situations (multi-corner, rounded, multiple obstacles)
- Separation line made up of many pieces of analytic functions
- Require numerical approximations
- Improved definition of the density: better precision for estimators (for mean speed, flow) weighted by the density



Future works

- Development of **algorithms for systematic calculation** of the Voronoi diagrams on arbitrary geometries including obstacles
- Development of **numerical heuristics** and estimation of the approximation errors
- Analyse on experimental data and quantitative **evaluation** of the empirical estimation **improvement**

References

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[2] Liddle, J. ; Seyfried, A. ; Steffen, B. Analysis of bottleneck motion using Voronoi diagrams *Pedestrian and Evacuation Dynamics*, Springer, 2011.

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