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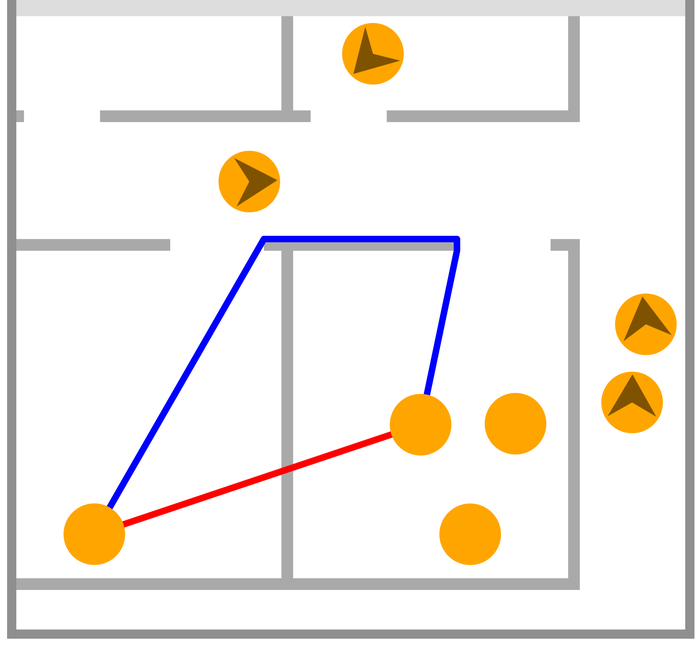
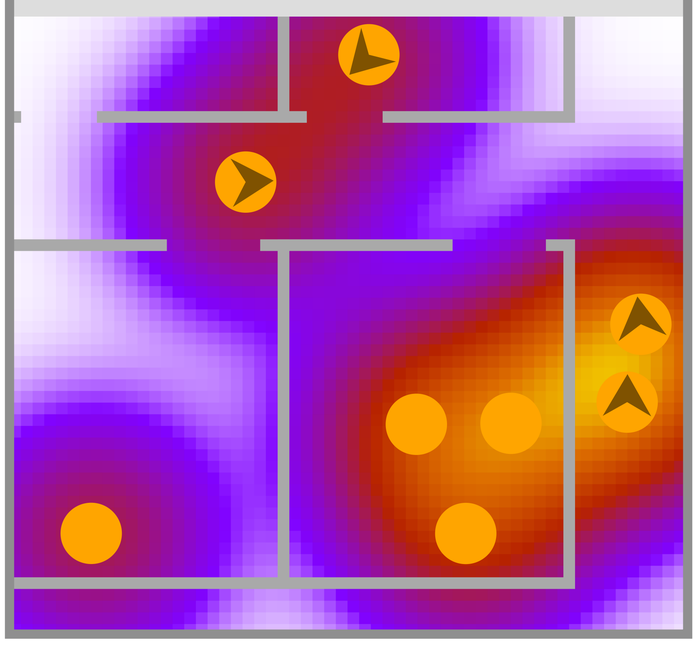
Measuring pedestrian safety

Different metrics for measuring pedestrian safety exist. The most common ones are **density**, **velocity**, **flow** and **pressure**. These metrics can be calculated using different methods, potentially leading to different conclusions concerning safety. We propose a methodology for comparing these metrics and refine existing metrics to include obstacles by using the **geodesic** distance instead of the **Euclidean** distance.

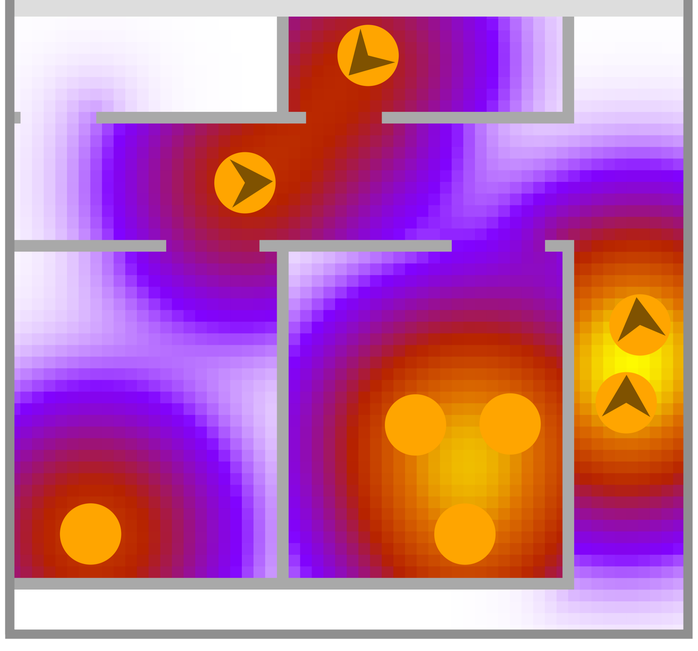
The **Euclidean** and **geodesic** distance between two pedestrians.



A Gaussian density field using the Euclidean distance.

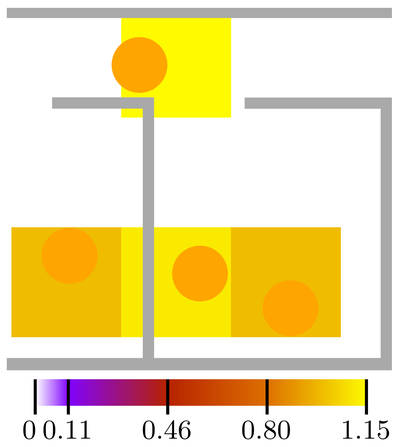


A Gaussian density field using the geodesic distance.

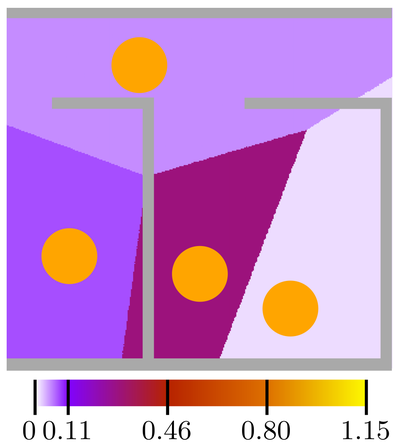


Methods

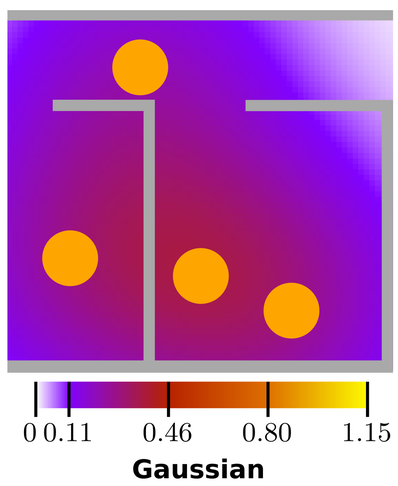
We compare grid-based, Voronoi-based and two Gaussian-based methods, which use the Euclidean distance. A shortcomming when using the Euclidean distance is that obstacles are not taken into account. We propose to use the **geodesic distance** to eleviate this problem.



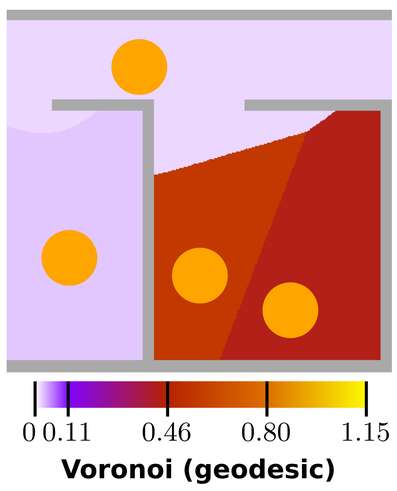
Grid



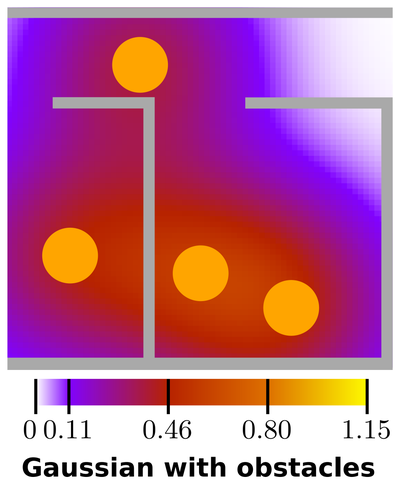
Voronoi



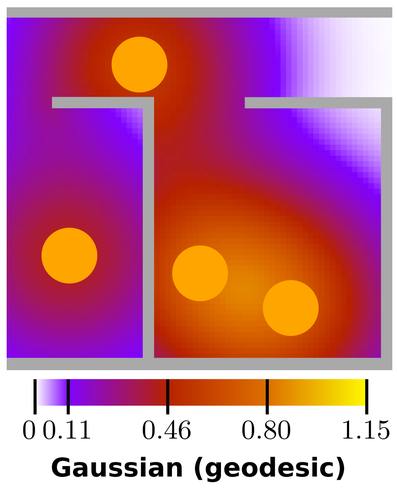
Gaussian



Voronoi (geodesic)



Gaussian with obstacles



Gaussian (geodesic)

Comparing metrics

Researchers often look at trends in fundamental diagrams or search for visual differences. This makes a proper statistical analysis difficult. Therefore, we look at four different analyses that make statistical analysis possible.

Analyses

Besides the **maximum** and the **maximum difference**, we define two new analyses.

The **quadratic score** can be used when two metrics give similar maxima. It calculates a characteristic score which emphasizes large differences with the maximum value.

A measured value can be mapped to a specific value. One such mapping is the Level of Service. The difference between these values results in the **bin-distance**.

Results

We tested the different metrics on three building blocks for environments and varied the number of pedestrians. We show the resulting analyses of density for one environment. We conclude that there are significant differences at the 95% confidence level.