Multi-agent simulation

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Overview

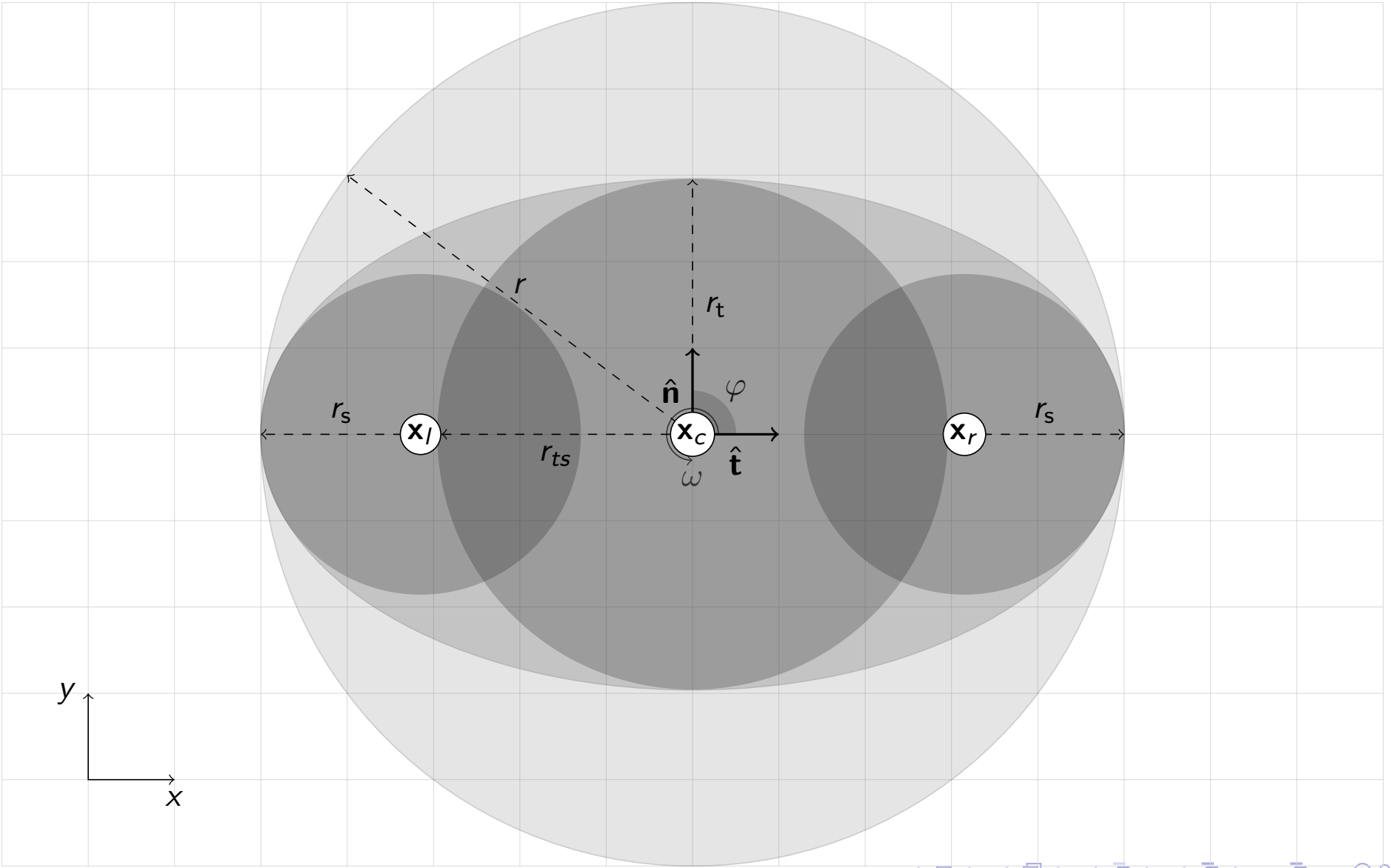
Introduction

A force based simulation model for crowd dynamics. i.e movement of people (agents) is modeled by hypotetical social force. Reminds of particle simulation.

Game theoretical model is used to model agent behavior in egress congestion (eq. evacuation).

Simulation model

Agent model



Simulation model

Social force model

Total force exerted on the agent is the sum of movement adjusting, social and contact forces between other agents and wall.

$$\mathbf{f}_i(t) = \mathbf{f}_i^{adj} + \sum_{j \neq i} \left(\mathbf{f}_{ij}^{soc} + \mathbf{f}_{ij}^{c} \right) + \sum_{w} \left(\mathbf{f}_{iw}^{soc} + \mathbf{f}_{iw}^{c} \right) + \boldsymbol{\xi}_i$$

Simulation model

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Force adjusting agent's movement towards desired in some characteristic time

$$\mathbf{f}^{adj} = \frac{m}{\tau^{adj}} (v_0 \cdot \hat{\mathbf{e}} - \mathbf{v})$$

Velocity dependent algorithm

$$\begin{aligned}
\mathbf{f}^{soc} &= -\nabla_{\tilde{\mathbf{x}}} E(\tau) \\
&= -\nabla_{\tilde{\mathbf{x}}} \left(\frac{k}{\tau^2} \exp\left(-\frac{\tau}{\tau_0} \right) \right) \\
&= -\left(\frac{k}{a\tau^2} \right) \left(\frac{2}{\tau} + \frac{1}{\tau_0} \right) \exp\left(-\frac{\tau}{\tau_0} \right) \left(\tilde{\mathbf{v}} - \frac{a\tilde{\mathbf{x}} + b\tilde{\mathbf{v}}}{d} \right),
\end{aligned}$$

where

$$\begin{aligned}
a &= \tilde{\mathbf{v}} \cdot \tilde{\mathbf{v}} \\
b &= -\tilde{\mathbf{x}} \cdot \tilde{\mathbf{v}} \\
c &= \tilde{\mathbf{x}} \cdot \tilde{\mathbf{x}} - \tilde{r}^2 \\
d &= \sqrt{b^2 - ac}, \quad b^2 - ac > 0 \\
\tau &= \frac{b - d}{a} > 0.
\end{aligned}$$

Simulation model

Rotational motion

Simulation model

System of differential equations

Simulation model

Game theoretical model

Simulations

Egress congestion

Simulations

References

John Smith (2012)

Title of the publication

Journal Name 12(3), 45 – 678.

The End