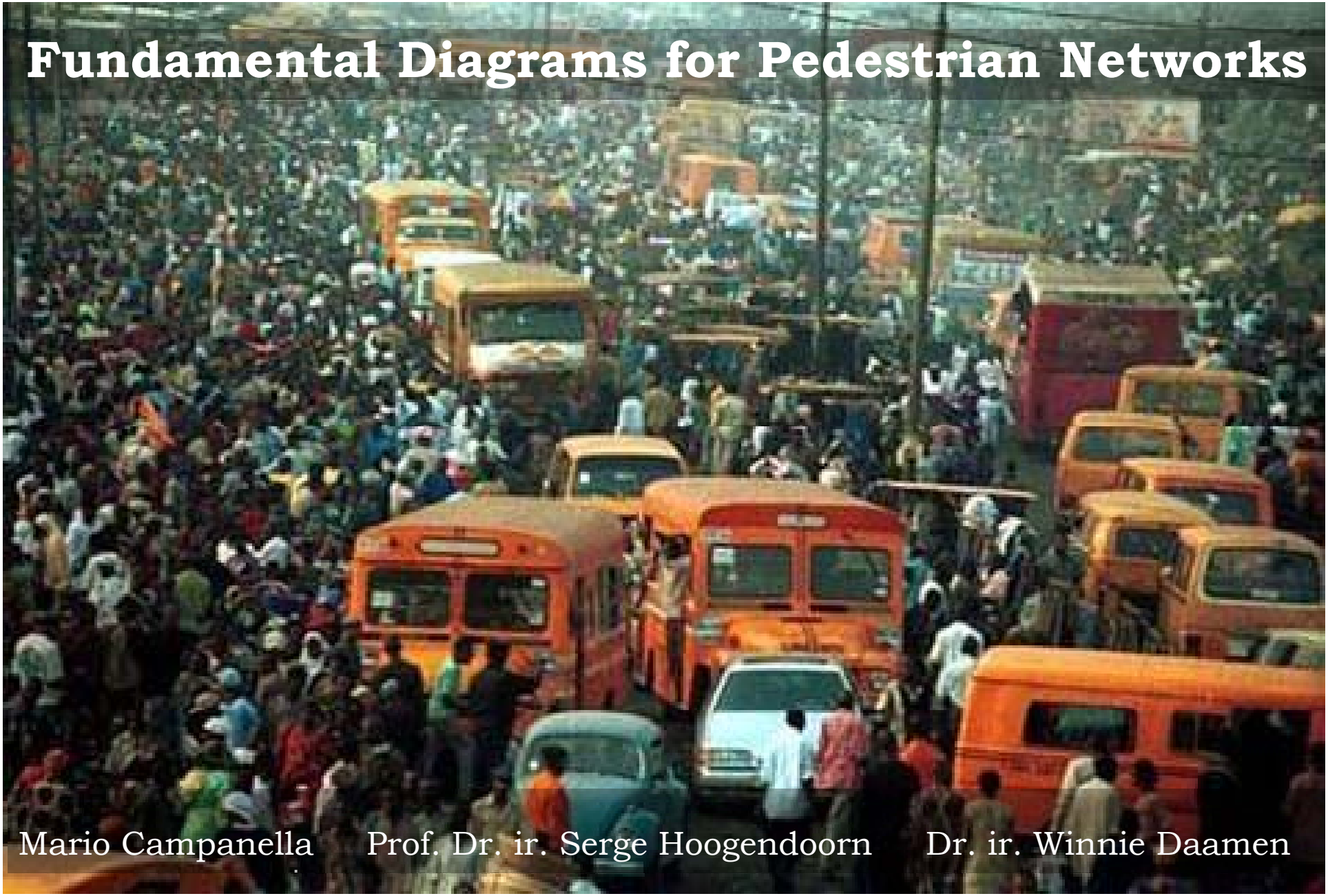
Fundamental Diagrams for Pedestrian Networks



Mario Campanella Prof. Dr. ir. Serge Hoogendoorn Dr. ir. Winnie Daamen

TU Delft

Delft University of Technology
Transport and Planning - CITG

Outline

Motivation and Introduction

NFD definition

NFD from experimental data

NFD from simulated data

Concepts and Applications

Conclusion

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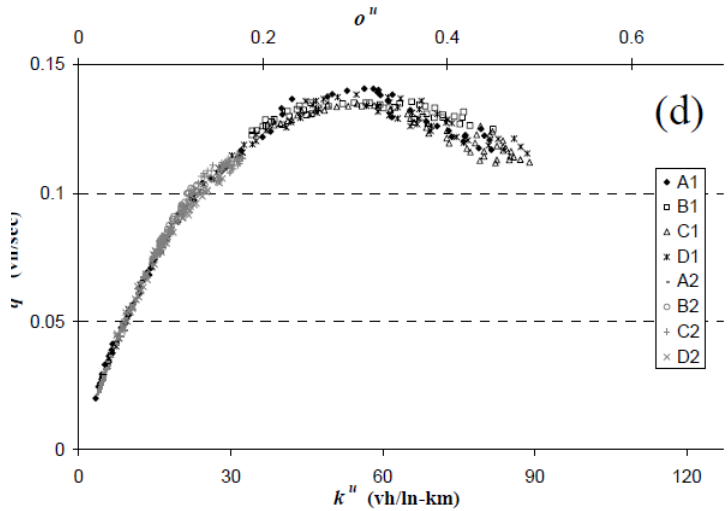
How to improve the planning and the control of large pedestrian flows in real time with simple methods.

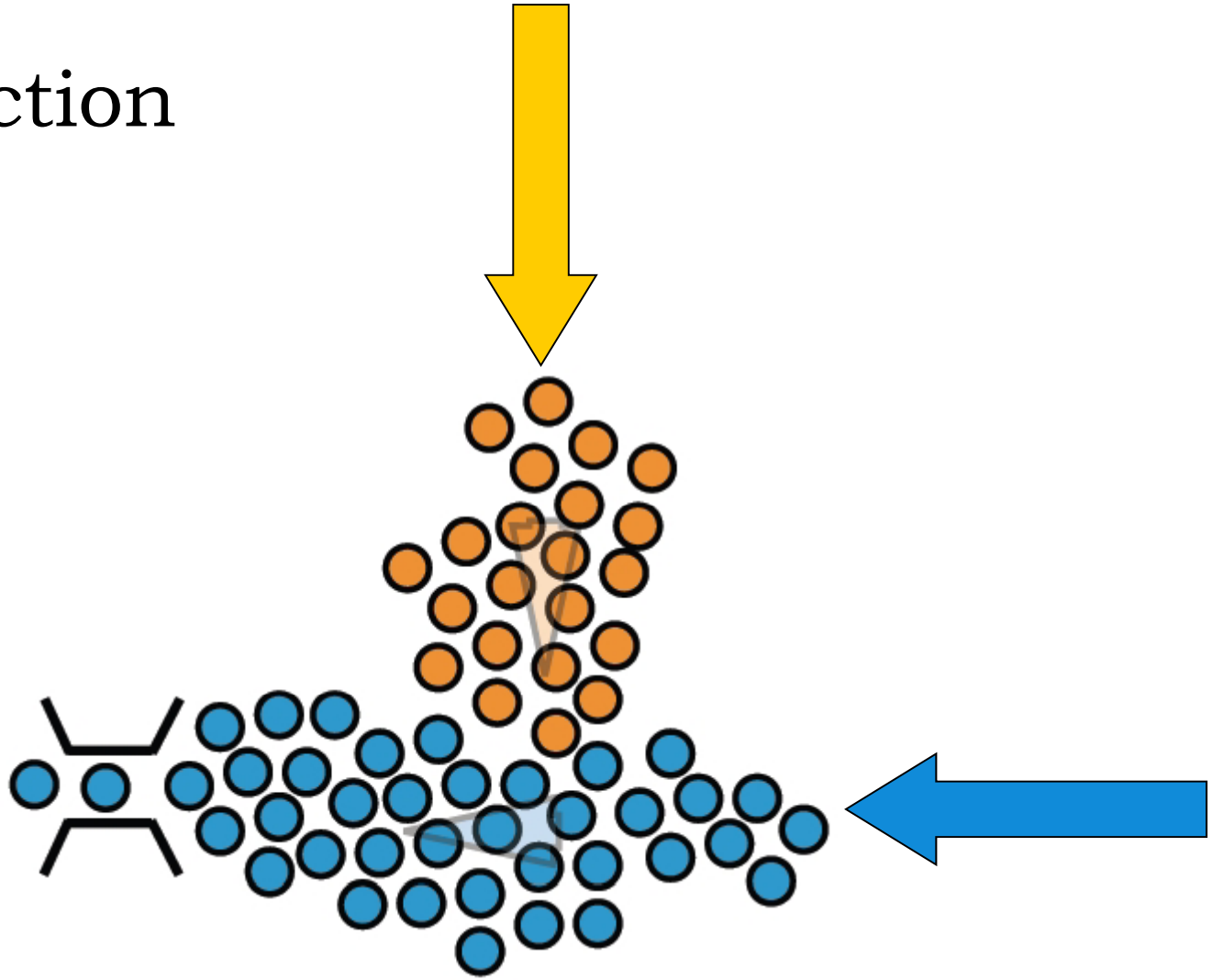
Introduction

Network Fundamental Diagrams for car traffic networks



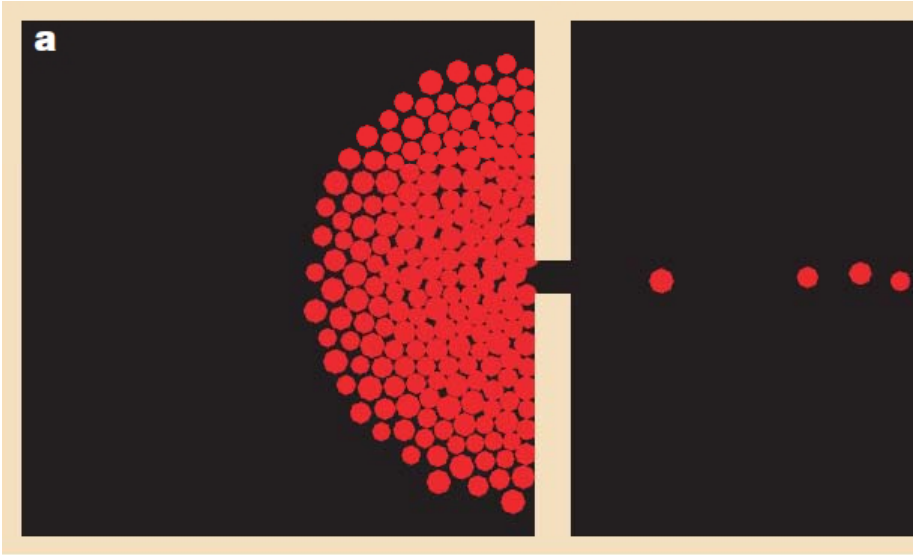
From Geroliminis and Daganzo (2007)

Introduction



spillback

Introduction



Faster is slower from:

Helbing, D.; Farkas, I. & Vicsek, T.

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NFD definitions

location: $\vec{x}_\alpha$

consider time period: $T = [t_0 - t_1]$

distance: $\vec{d}_\alpha = \vec{x}_\alpha(t_0 + \tau_\alpha) - \vec{x}_\alpha(t_0)$

walking time: τ_α

generalized velocity: $\vec{u} := \dfrac{\sum_{\alpha \in A} \vec{d}_\alpha}{\sum_{\alpha \in A} \tau_\alpha}$

NFD definitions

generalized density: $k := \frac{\sum_{\alpha \in A} \tau_\alpha}{|T||A|}$

acumulation: $n := k|A|$

generalized flow: $Q := kU$

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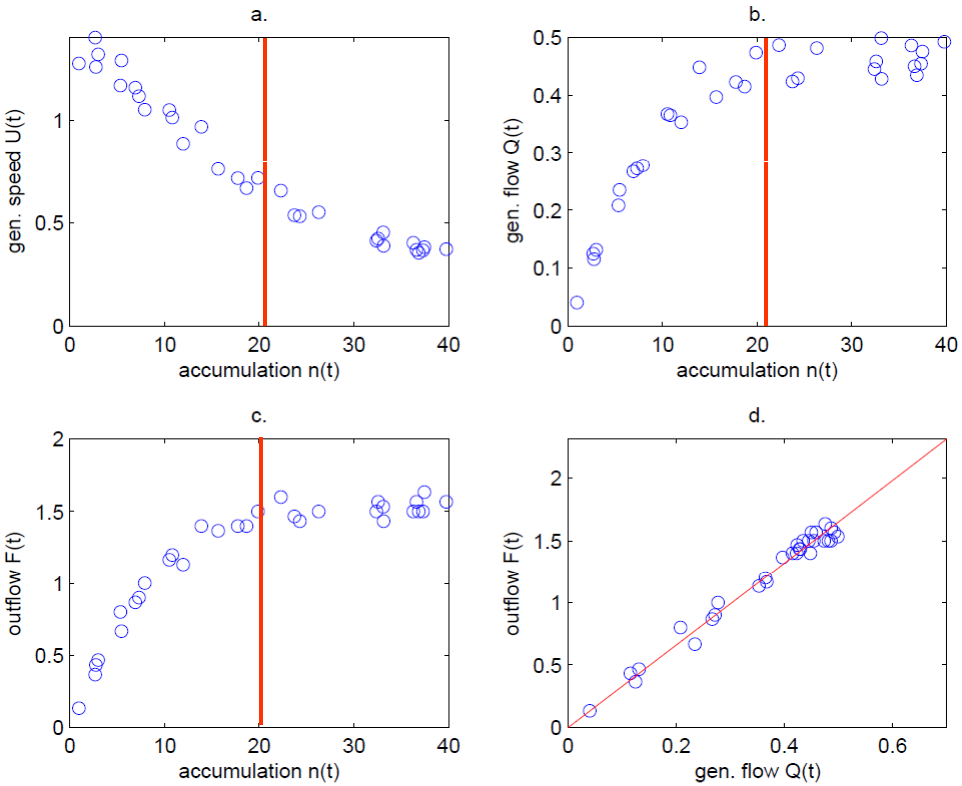
NFD from experimental data

Narrow bottleneck



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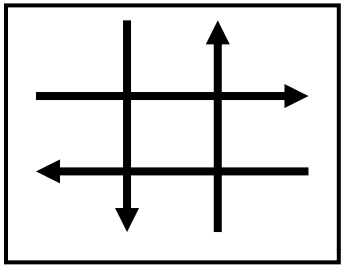
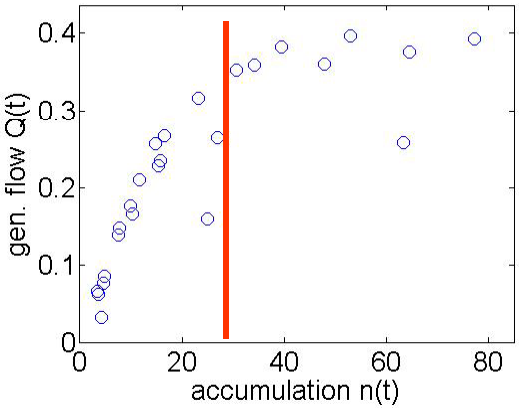
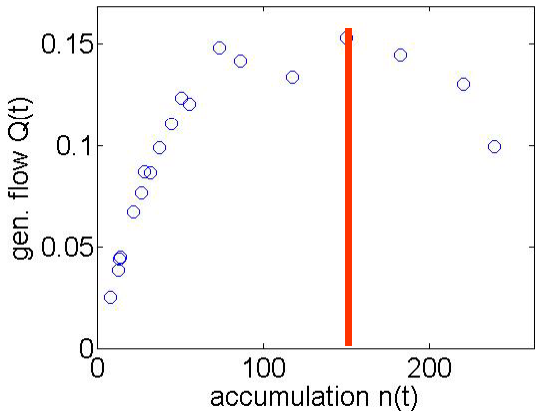
NFD from simulated data





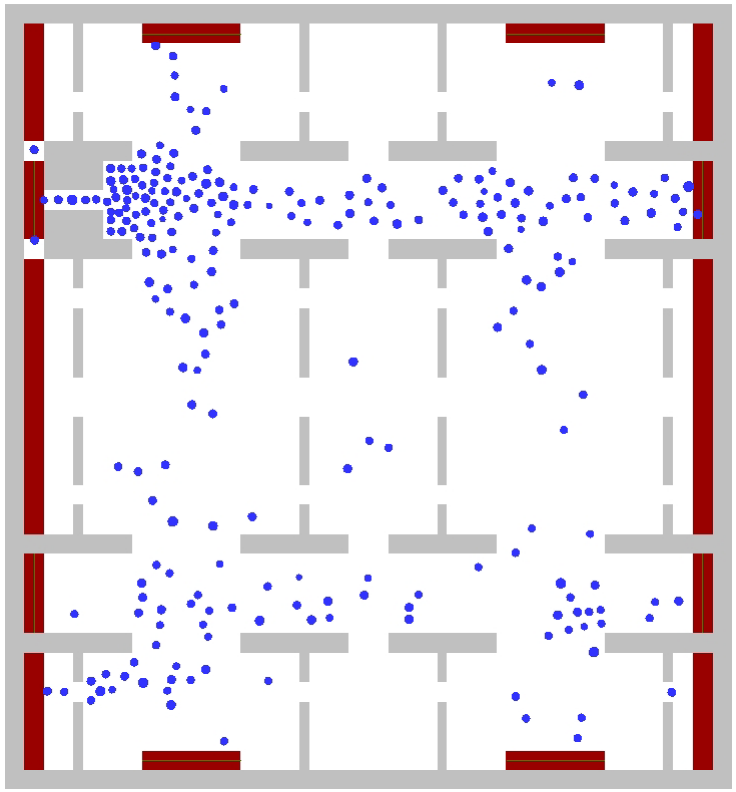
n_{crit}



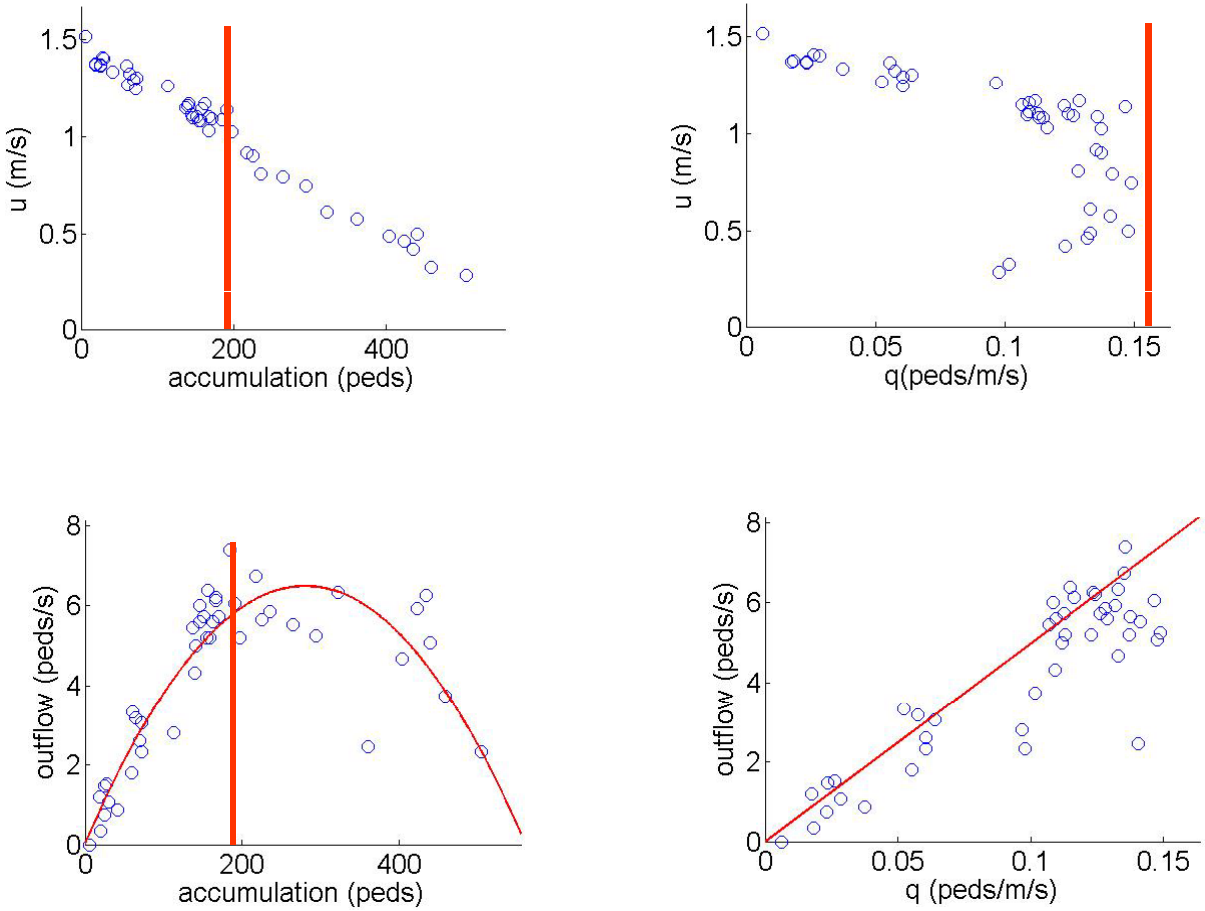
Narrow bottleneck flow

Crossing flow

NFD from simulated data



NFD from simulated data



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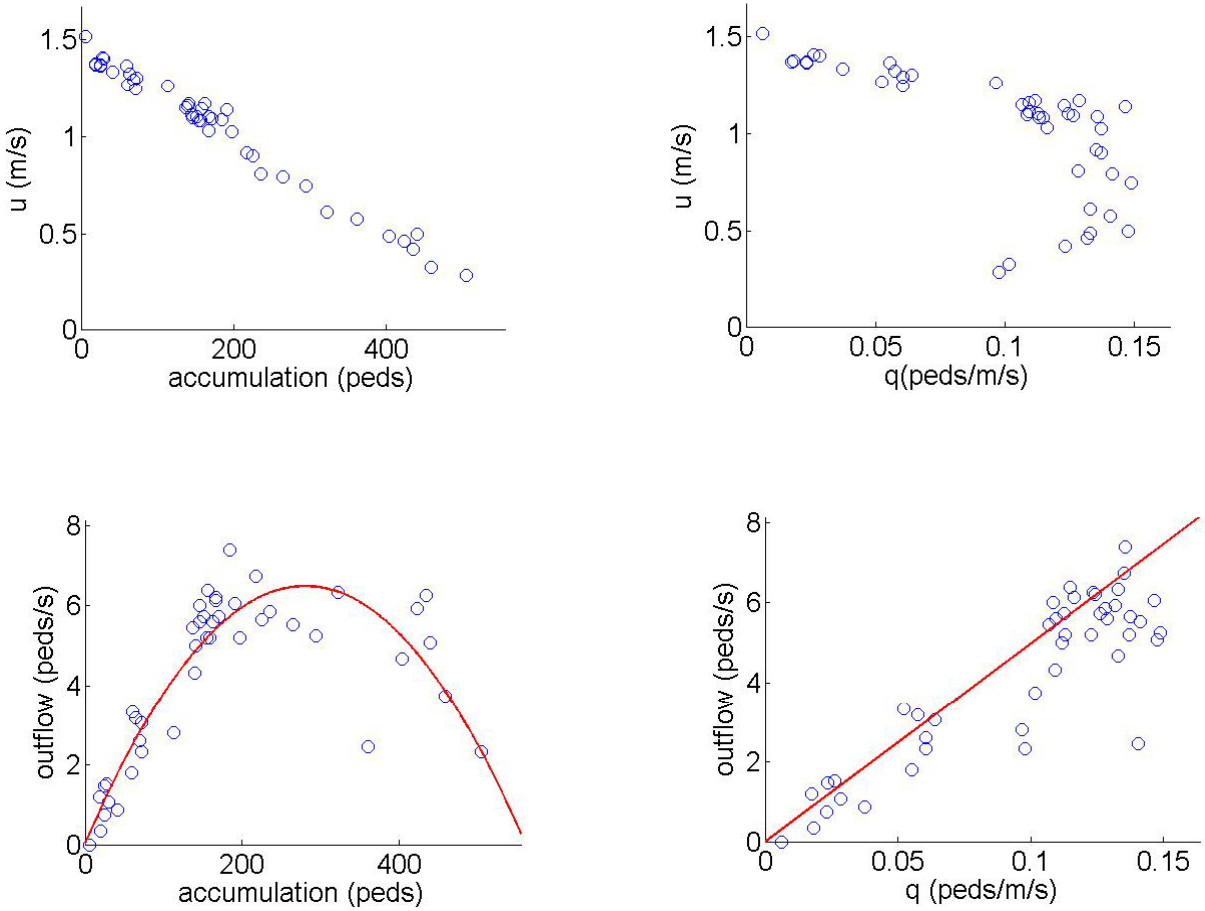
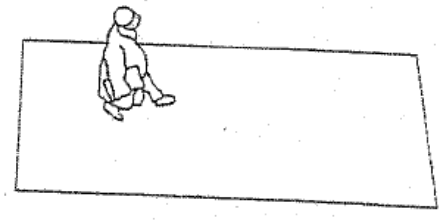
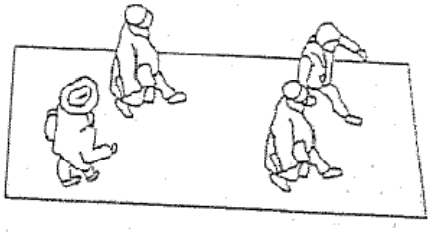
Calibration/validation of models



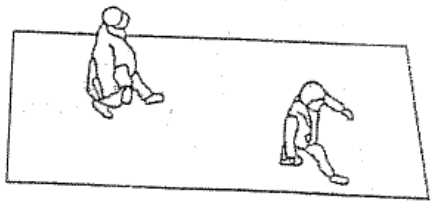
Network wide level of service



LOS A

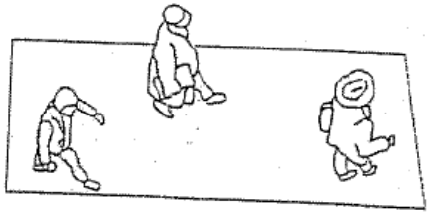


LOS D

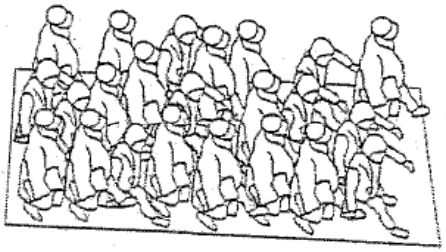


LOS B

LOS E



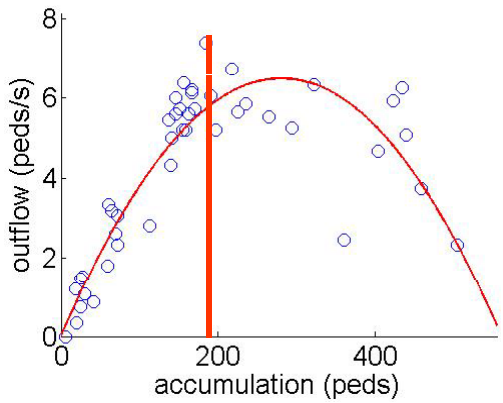
LOS C



LOS F

Crowd control – network wide

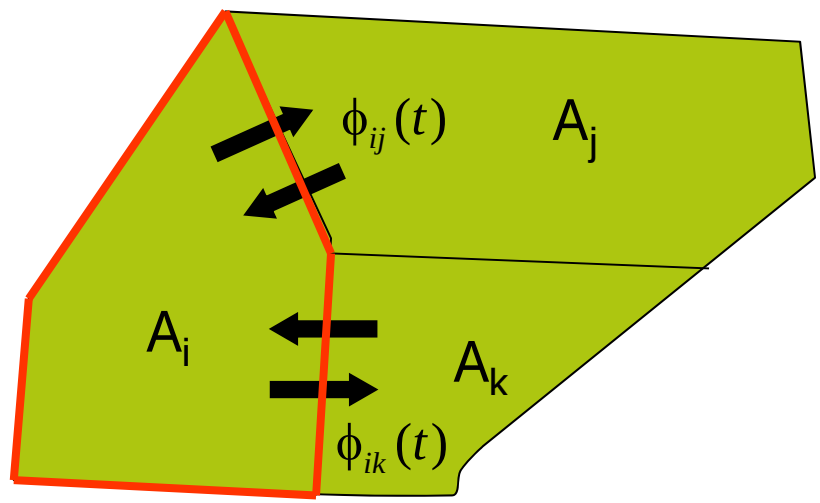
n'_{crit} = 200 peds



Crowd control – critical subparts

$$\frac{dn_i}{dt} = \sum_j f_{ij}(t) - F_i(n_i(t))$$

$$f_{ij}(t) = \phi_{ij}(t) F(n_i(t))$$



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Conclusion and further research

MFD's for pedestrian flows can be defined.

Shape of the MFD's is strongly dependent of the shape of the walking area, size and type of the flow (bottleneck, bidirectional, crossing...)

The shape of the MFD shows the n_{crit} in which the performance of the area starts to deteriorate. This information can be used for many purposes like: crowd control, network wide LoS identification, coarse dynamic modelling

Future research will aim to collect empirical data from large areas (with congestion) for further investigation.

Thanks! Questions?

Nomad Pedestrian Simulation Tool

www.pedestrians.tudelft.nl