Ruling Principles for Decision-Based Pedestrian Model

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Katedra matematiky FJFI ČVUT v Praze

Modeling of Pedestrian Dynamics - Motivation

Outline

- Modeling of Pedestrian Dynamics
- Phases of the Decision-Making
- Is it Real?

Modeling of Pedestrian Dynamics - Classification

- Space and Time Representation $\left\{ \begin{array}{l} \text{Discrete} \\ \text{Continuous} \\ \text{Mixed} \end{array} \right.$

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  - Discrete
  - Continuous
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  - Stochastic
- Population Representation
  - Macroscopic
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    - Acceleration-Based
    - Velocity-Based
    - Decision-Based

Modeling of Pedestrian Dynamics - Our Approach

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  - Mixed
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  - **Microscopic**
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    - Velocity-Based
    - **Decision-Based**

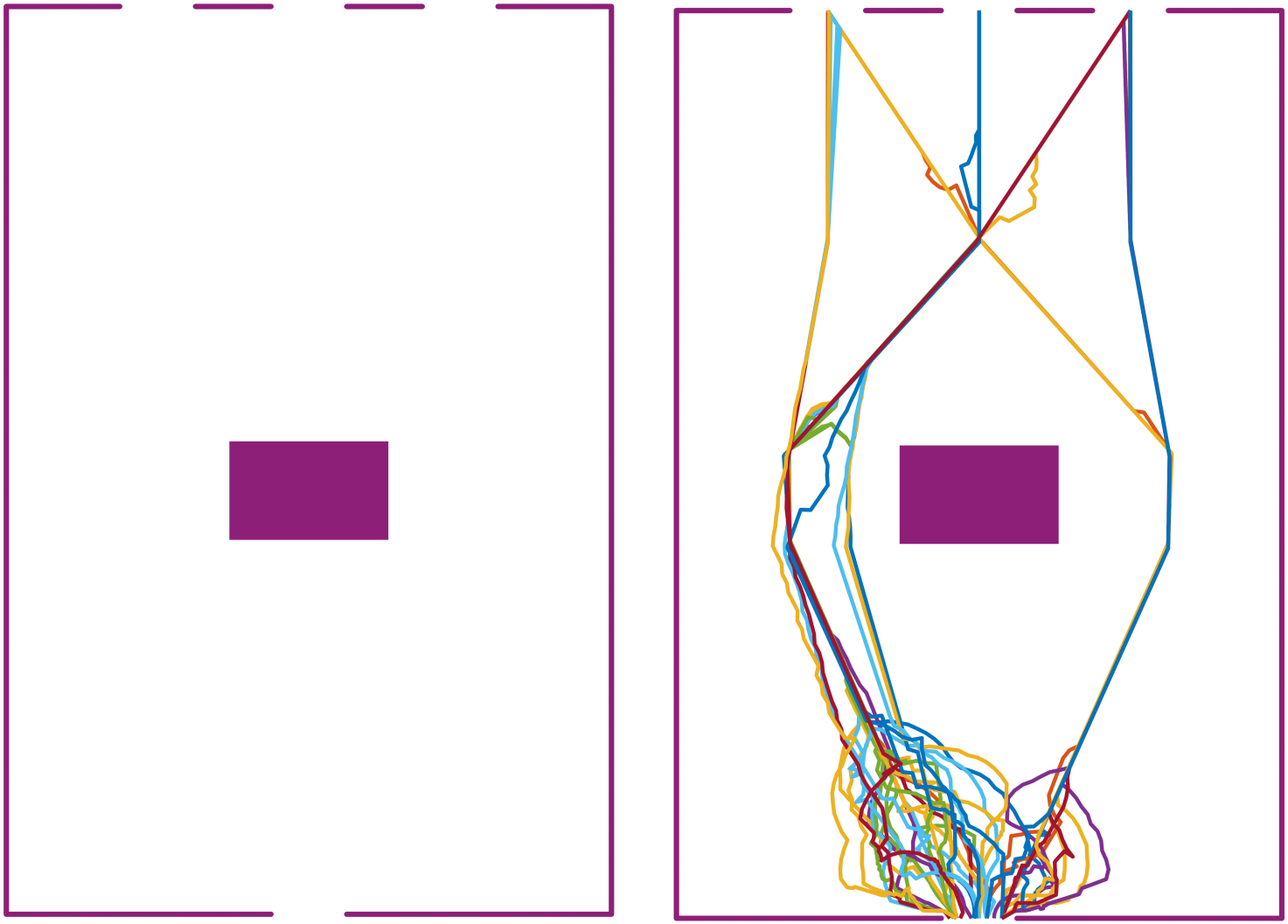
Phases of the Decision-Making - In General

- Strategic phase
  - Defines the global plan of the pedestrian (at the beginning)
- Tactical Phase
  - Represents local searches for possible positions to move (at each time step, for several time steps)
- Operational Phase
  - Describes next decisions taken by the pedestrian to reach the goal (at each time step, for one time step)

Phases of the Decision-Making - Our Rules

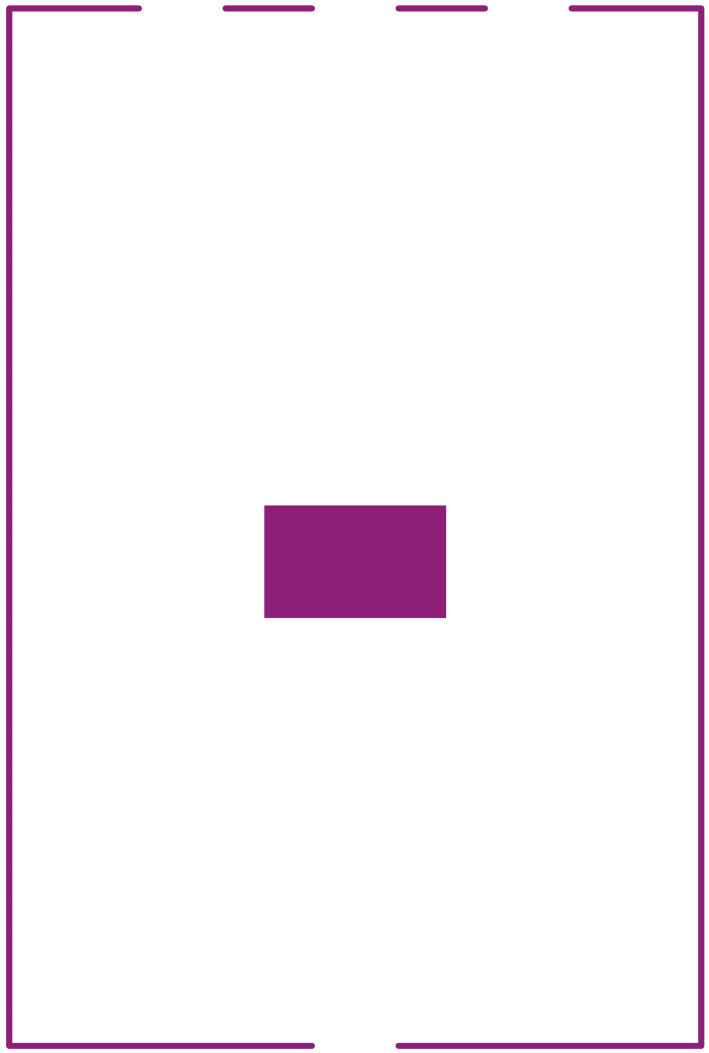
- Strategic Phase
  - To the Exit
- Tactical Phase
  - Selection of Local Targets
- Operational Phase
  - Blind Velocity
  - Collision Avoidance
  - Dense Crowd Behavior

Strategic Phase - To the Exit



Tactical Phase - Selection of Local Targets

- Tactical Phase = the time series of checkpoints from different levels
- Checkpoint = a local target
- Level = the set of checkpoints with the same y-coordinate



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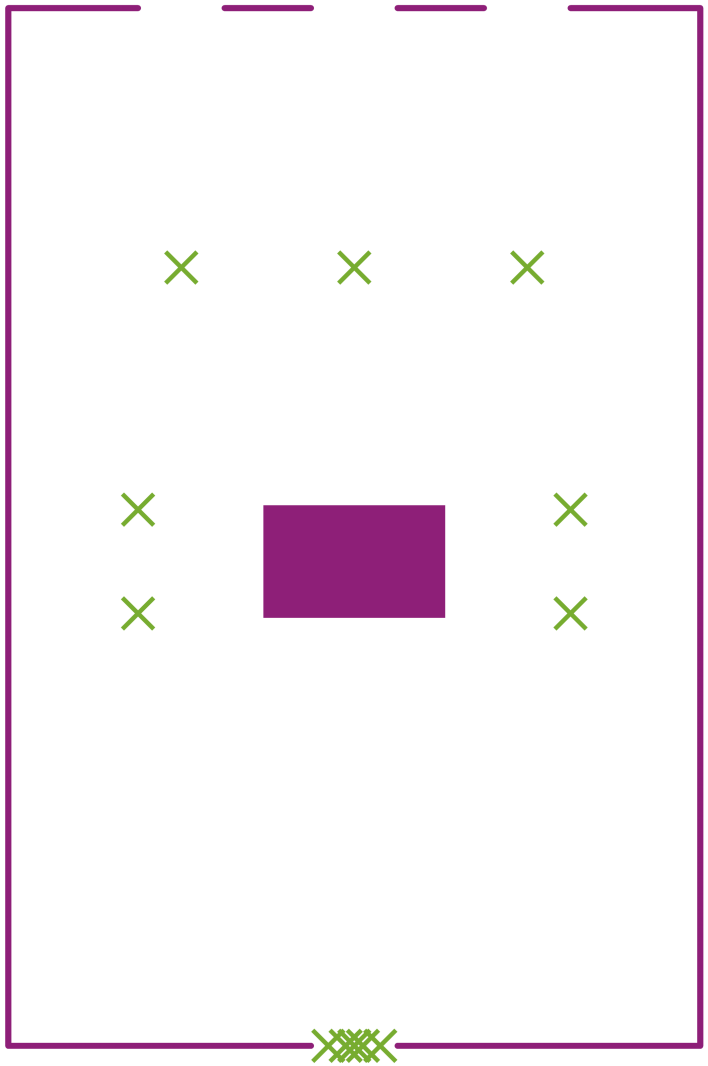

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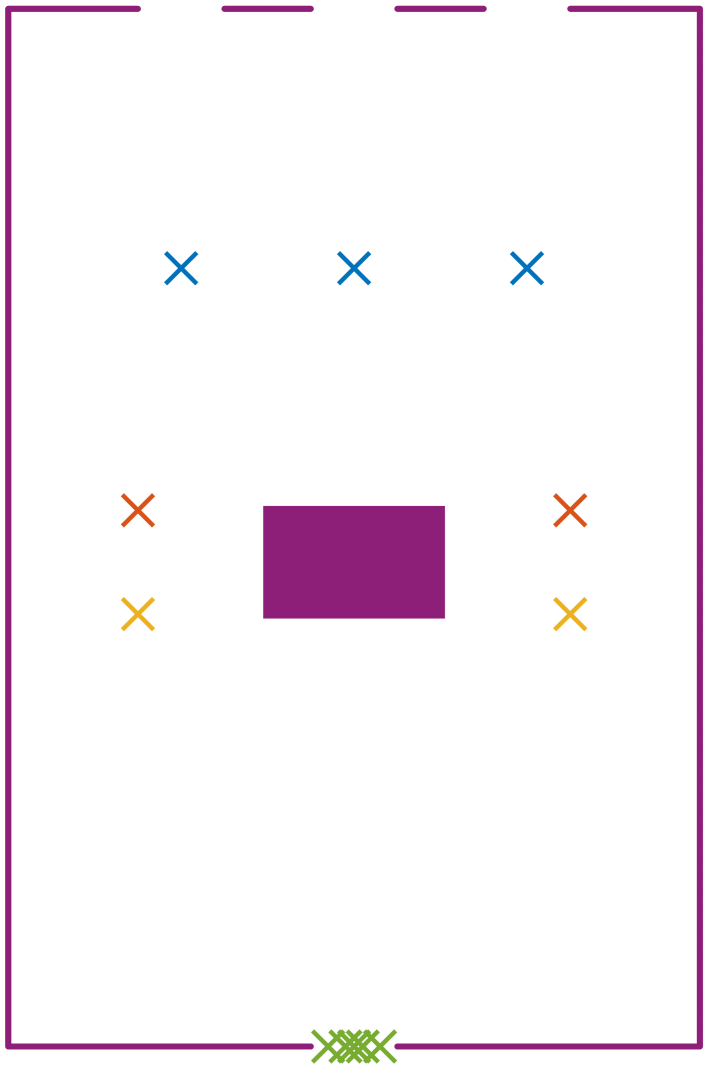
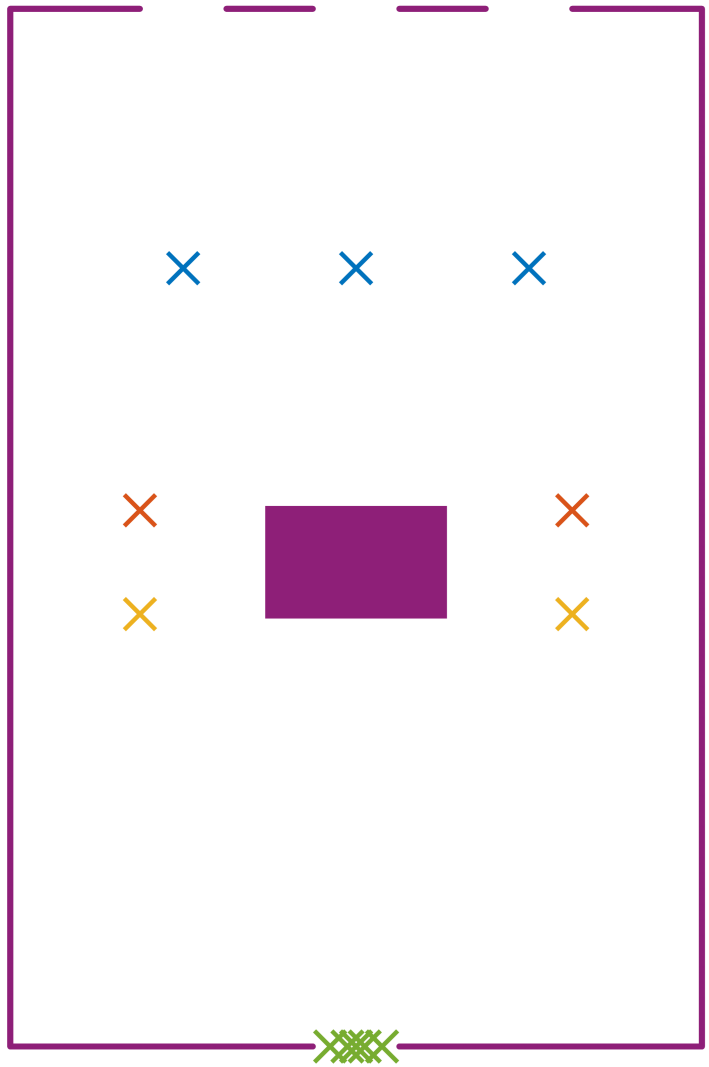


Tactical Phase - Selection of Local Targets

- Checkpoints from the level are selected at each time step taking into account the distance from the pedestrian current position and a probability
  - Checkpoint is selected randomly from the nearest checkpoints
  - Checkpoint constancy: the same checkpoint as in the previous time step is selected with a chosen (high) probability
  - If the pedestrian is close enough to the current checkpoint, the checkpoint is changed with zero probability



Operational Phase - Blind Velocity

- Blind direction - minimalizes pedestrian distance to the selected checkpoint
- Blind speed - pedestrian accelerates from initial zero speed until the maximal possible one is fulfilled

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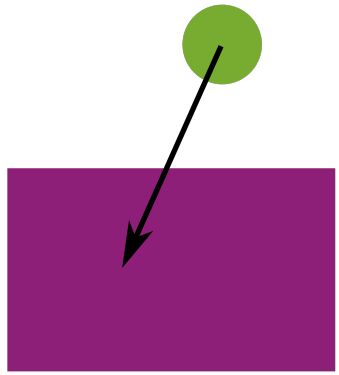
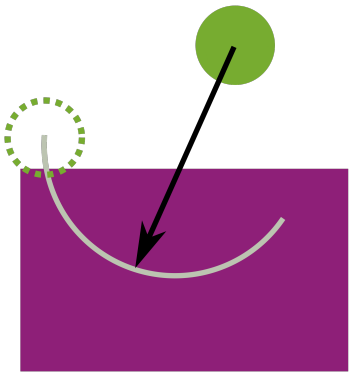


Operational Phase - Collision Avoidance

- By rotation with *maxCourseChange* angle
- By shortening the blind distance to the maximal possible one, i.e. the pedestrian slows down



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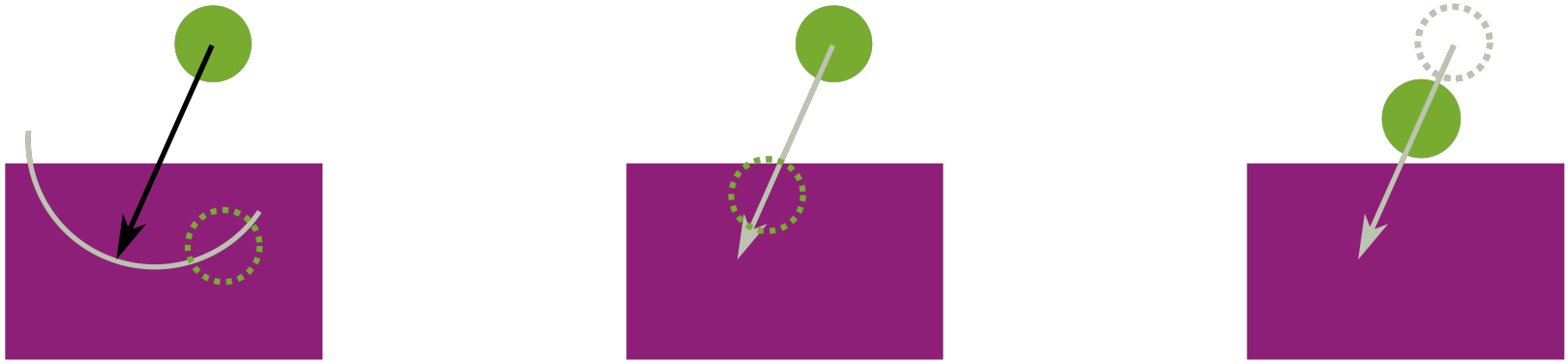
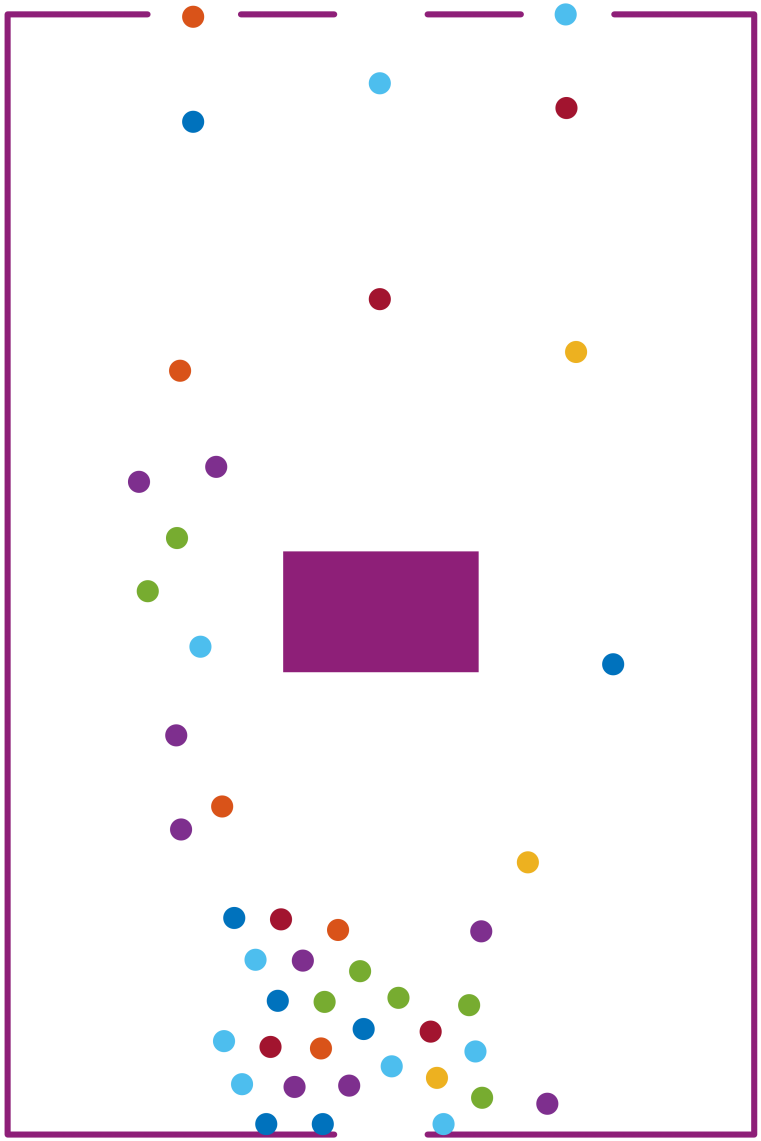


Operational Phase - Dense Crowd Behavior

- Pedestrian reduces their size (until a specific threshold is fulfilled)
- When the exit area is stuck, the pedestrian looks in the *viewAngle* and if there is a free space, accelerates with high acceleration *acceCrisis* and goes through the exit



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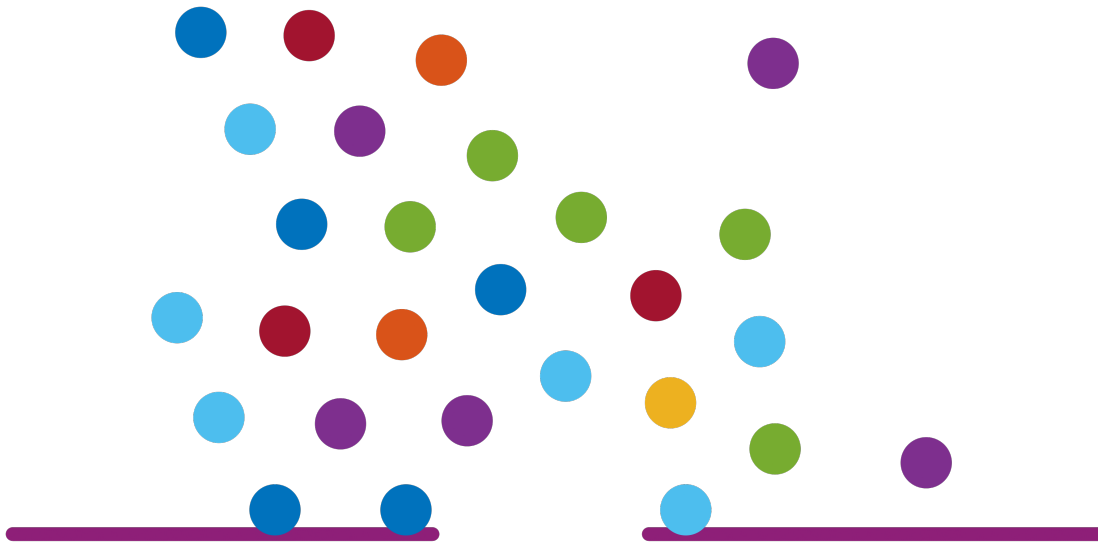

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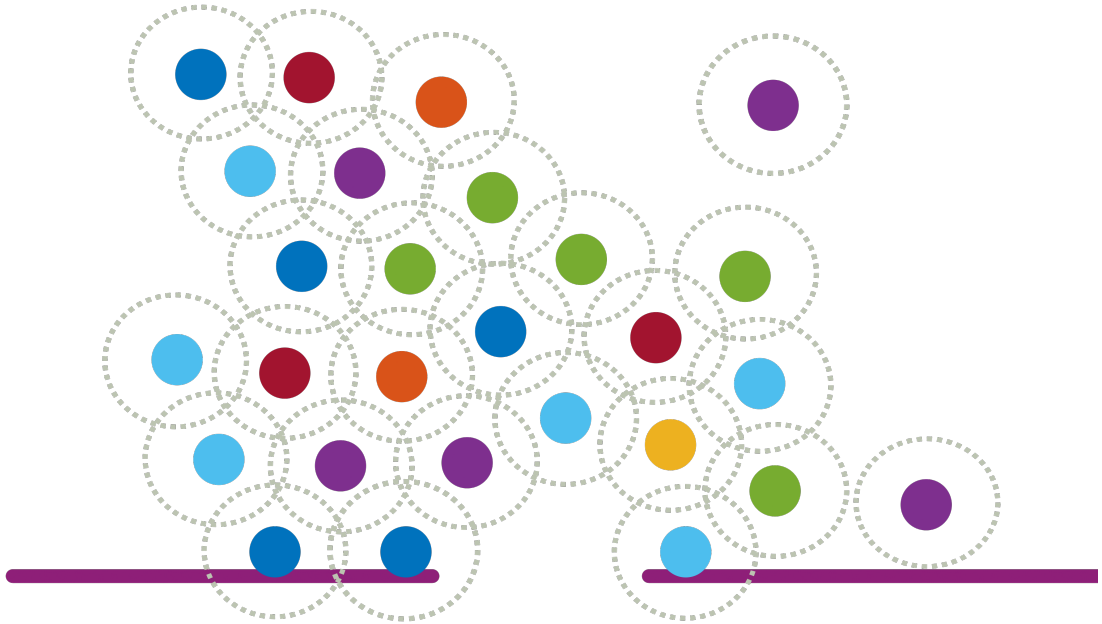

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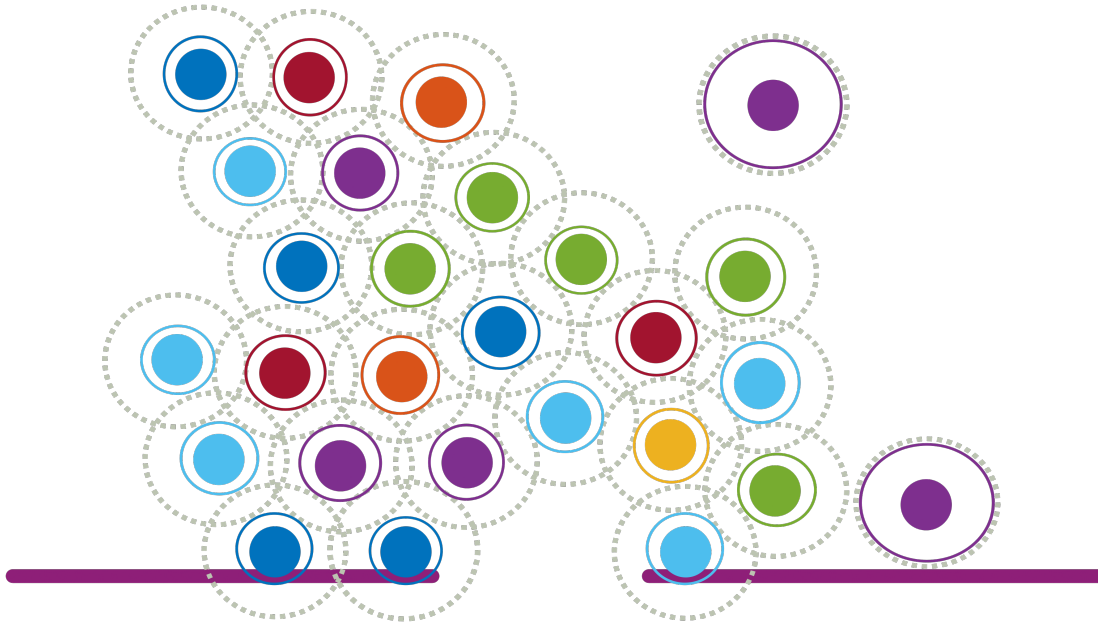

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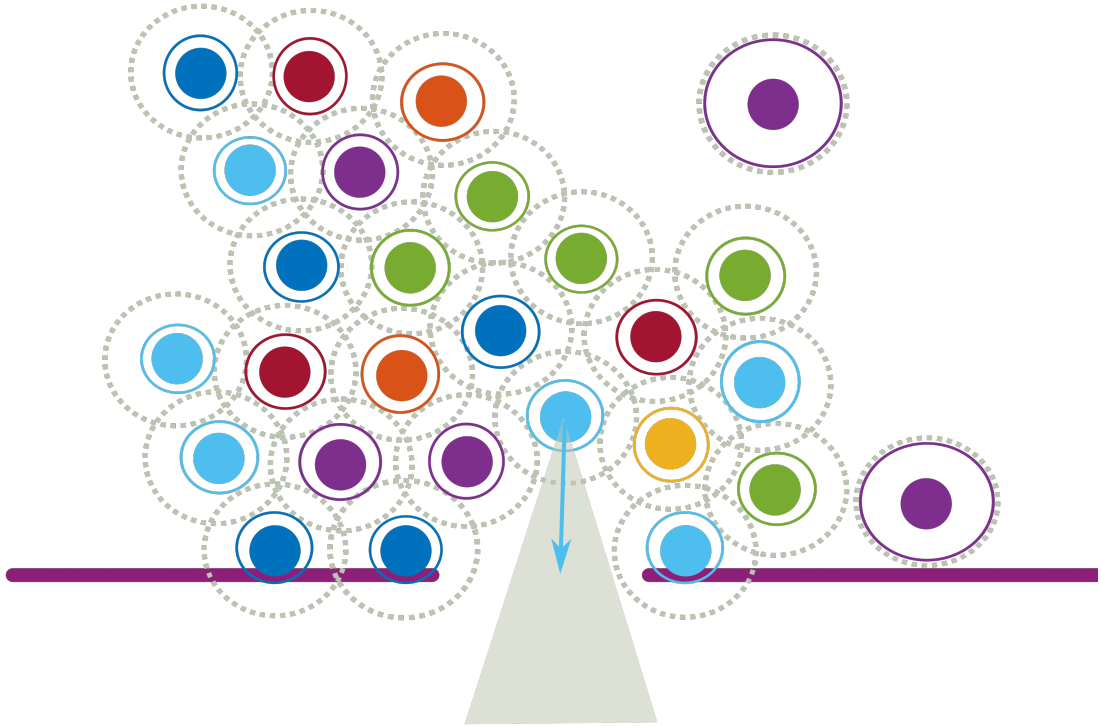

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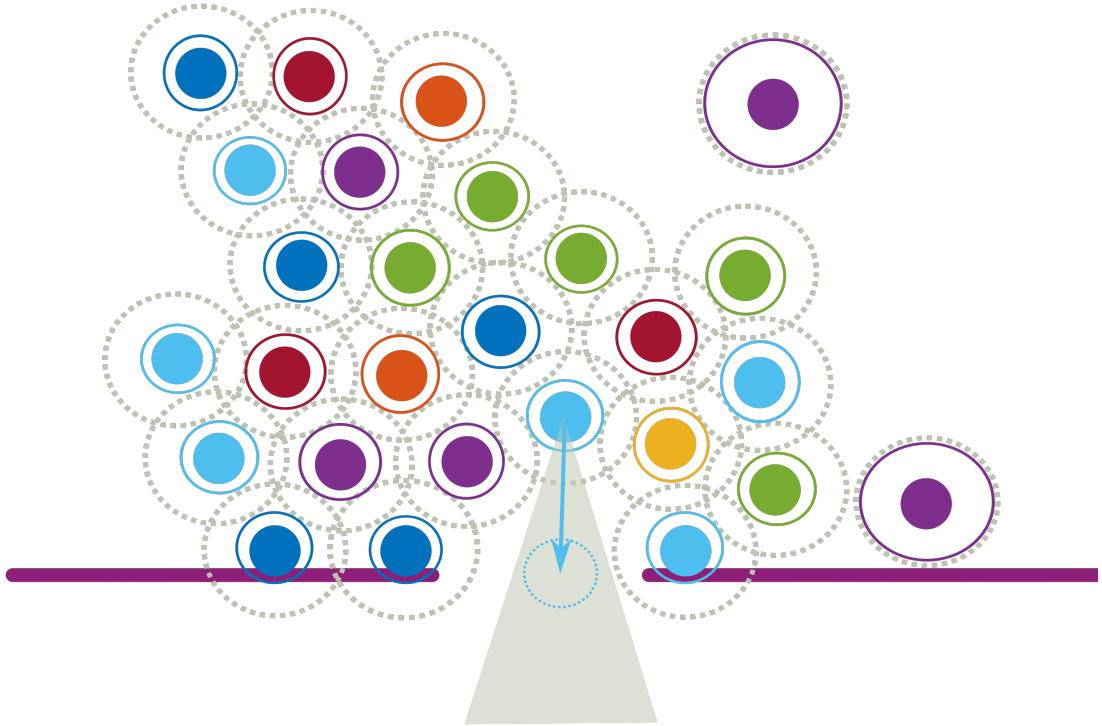

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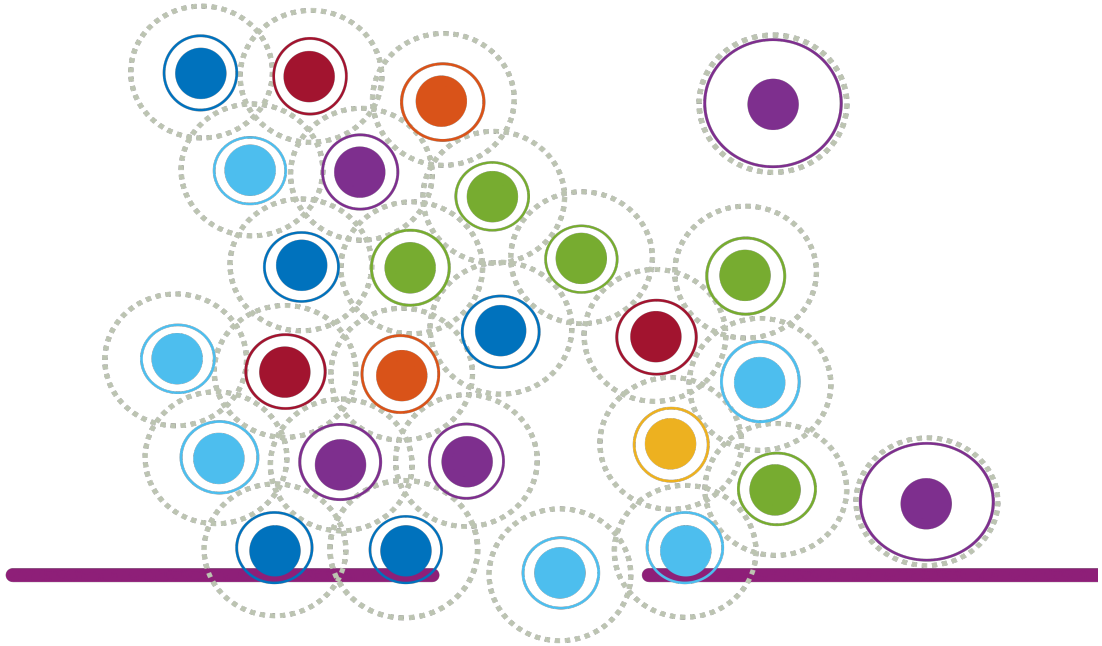

Showpiece

Is it Real? Model Parameters and Calibration

- tStep, xStep, alphaStep
- sizePed, reducePedStep, thresholdSizePed
- wallDistance
- vOpt, vIni, acce
- maxCourseChange
- acceCrisis, viewAngle
- epsAim

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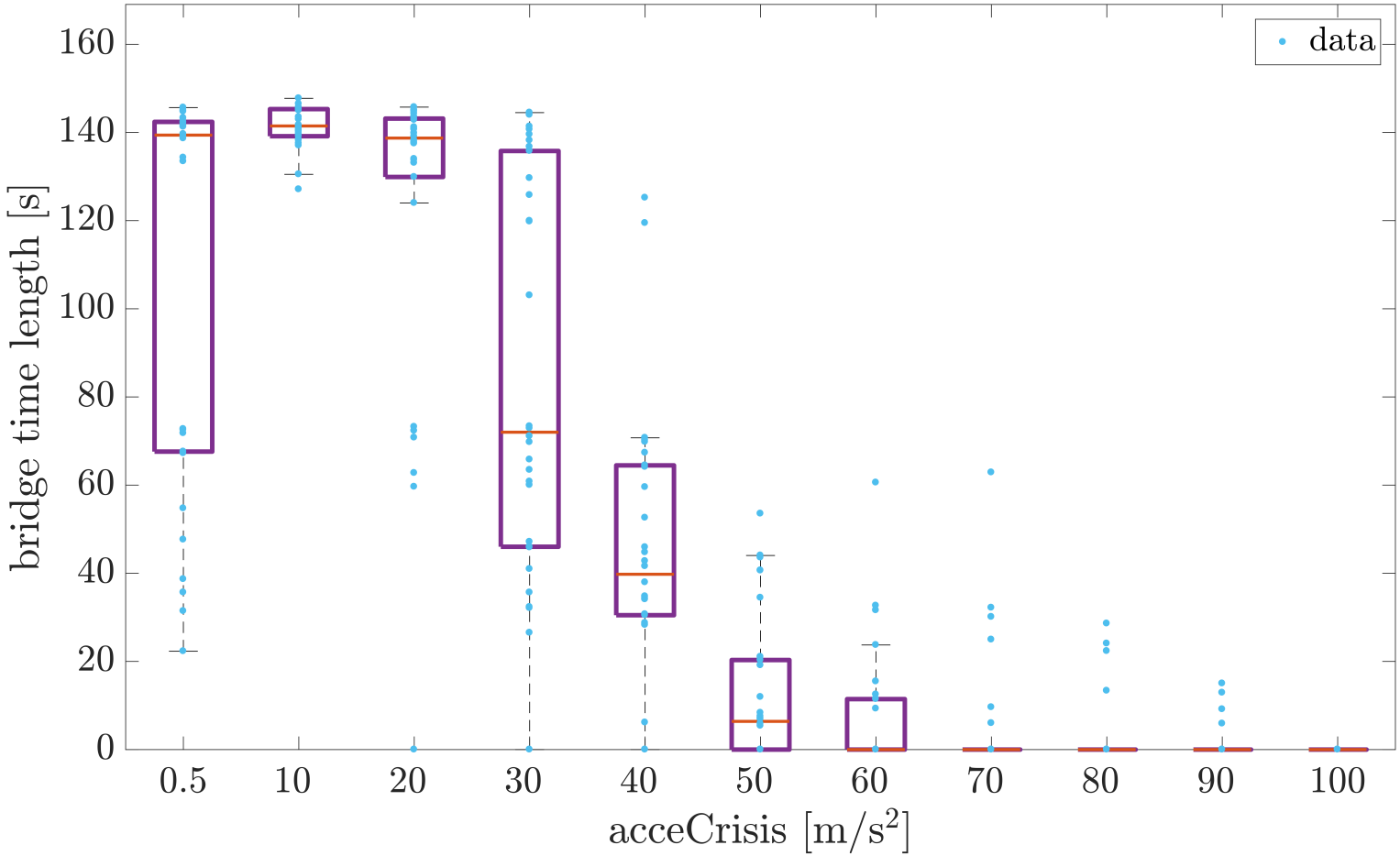

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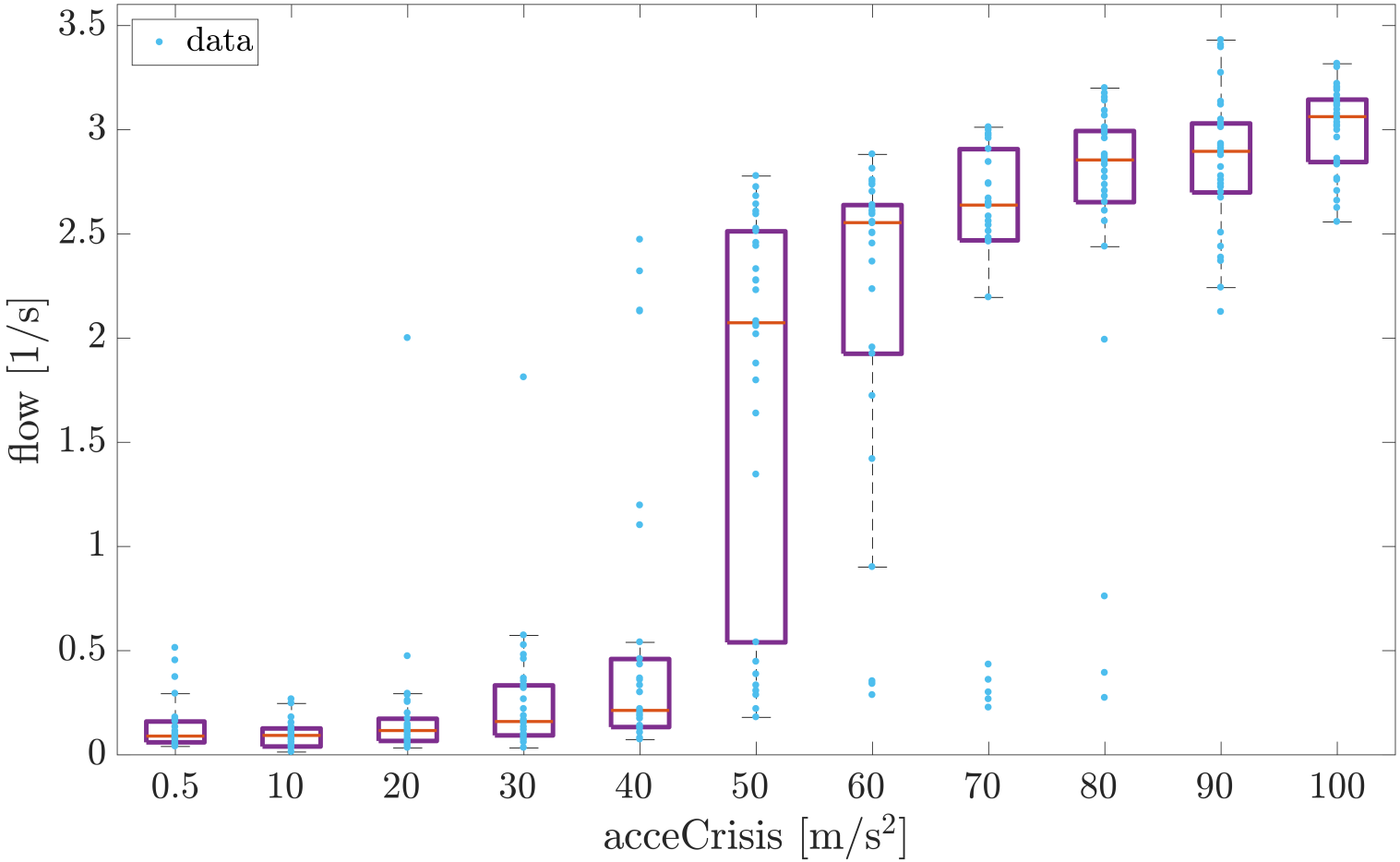

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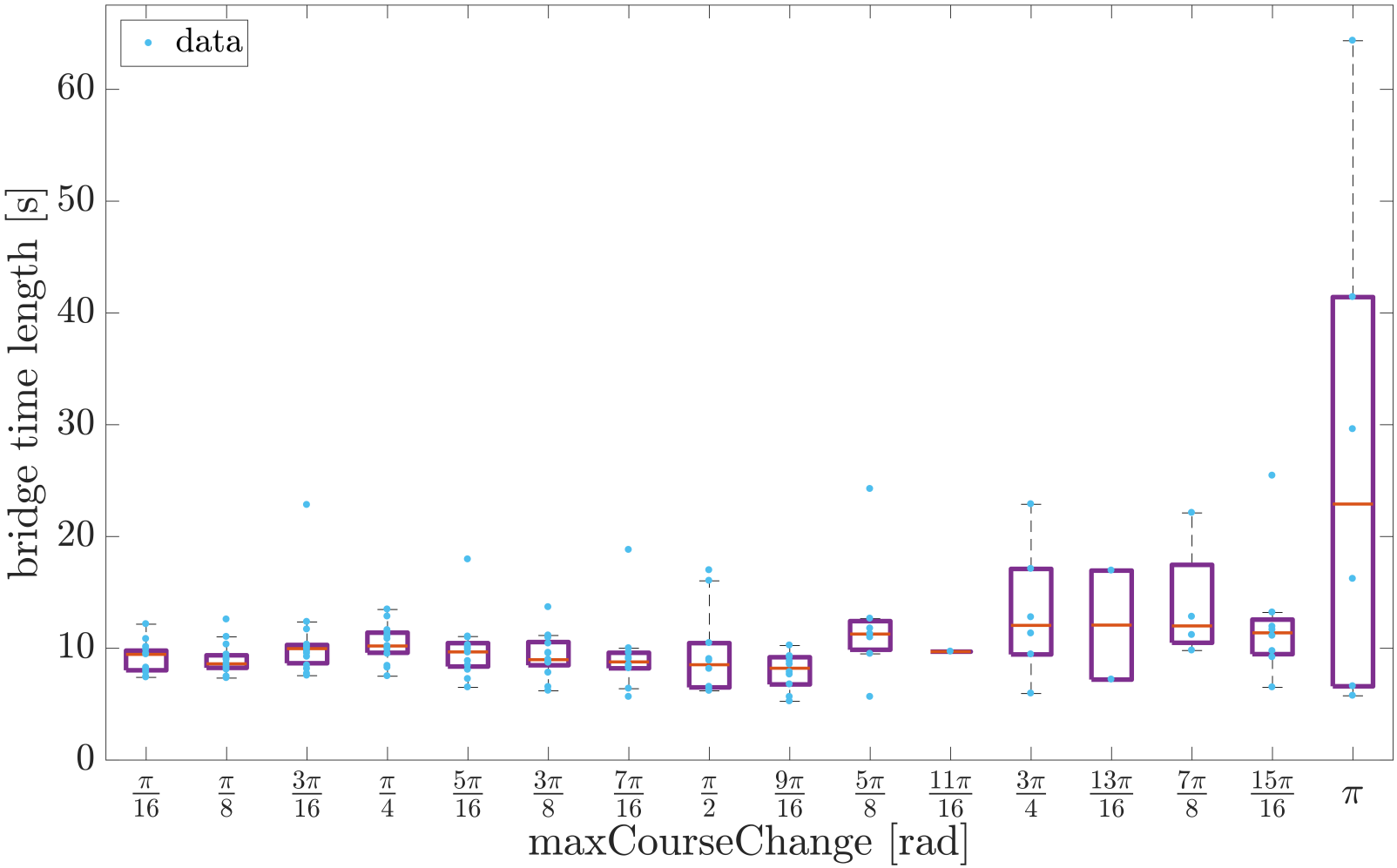

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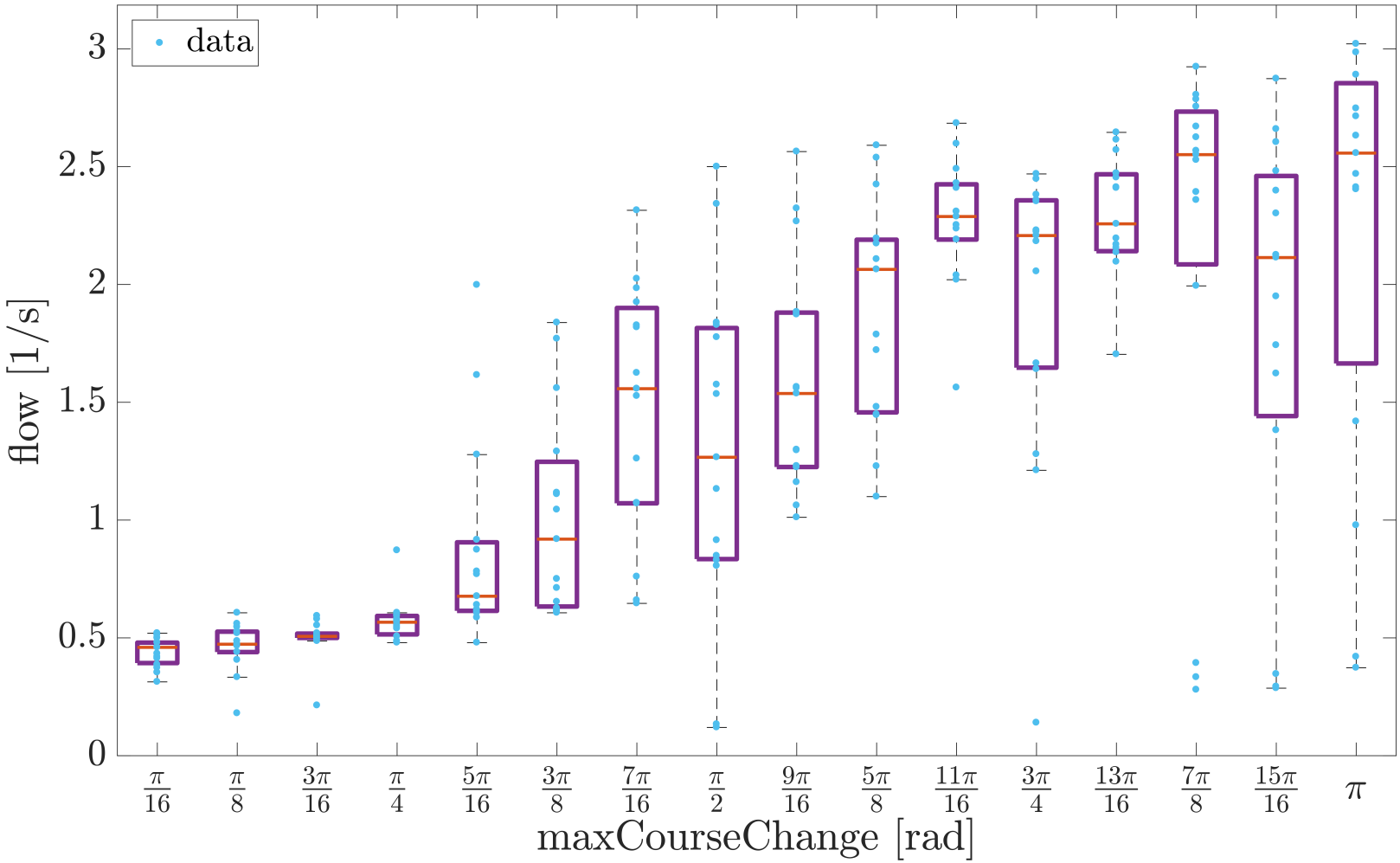

Conclusions

Done:

- Continuous model in time and space
- Rules for pedestrian movement
- Solved collision avoidance and dense crowd behavior

Next Steps:

- Precise calibration

Thank you for your attention.