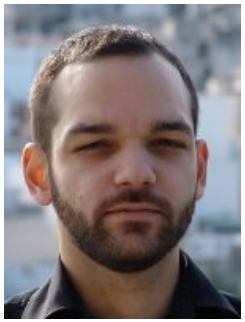
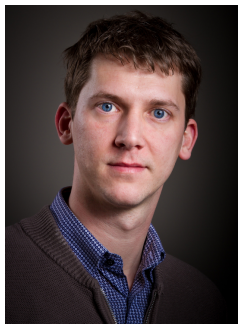
# Adding Sociality to Virtual Pedestrian Groups



Norman Jaklin


Angelos Kremyzas


Roland Geraerts


## VRST 2015


Universiteit Utrecht

COMMIT/

# Work of our Group: Navigation of Autonomous Virtual Agents

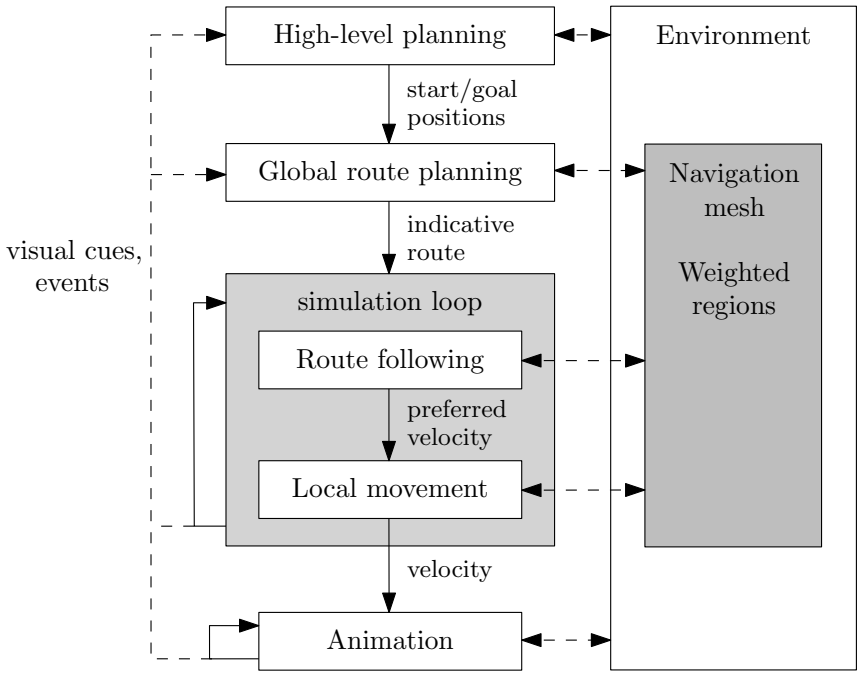
**Research involves**

- Crowd simulation
- Motion planning
- Navigation meshes
- Computational geometry
- Animation
- ...

**Application areas are**

- Crowd management for real-life mass events
- Safety-training software
- Simulation of evacuation scenarios
- Urban city planning
- Entertainment games
- ...

# Context:
# Five-level Agent-navigation Planning Hierarchy



# An Example Video of our Work

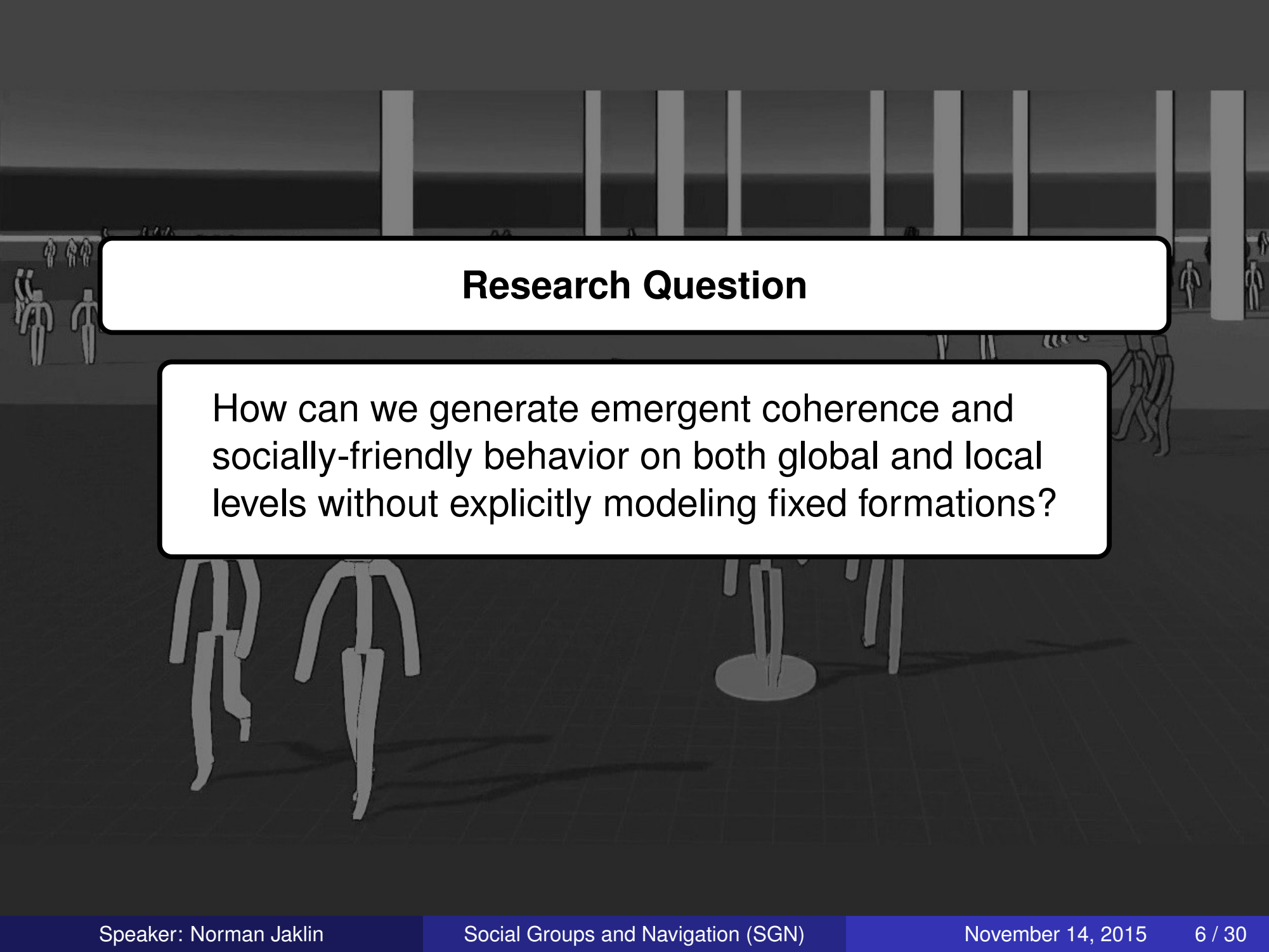
# Related Work on Social Groups

- Musse and Thalmann 1997
- Qui and Hu 2010
- Kamphuis and Overmars 2004
- Kimmel 2012
- Park et al 2012
- Huang et al. 2014
- Moussaïd et al. 2010
- Karamouzas and Overmars 2012
- Wu et al. 2013

$\Longrightarrow$

Existing methods

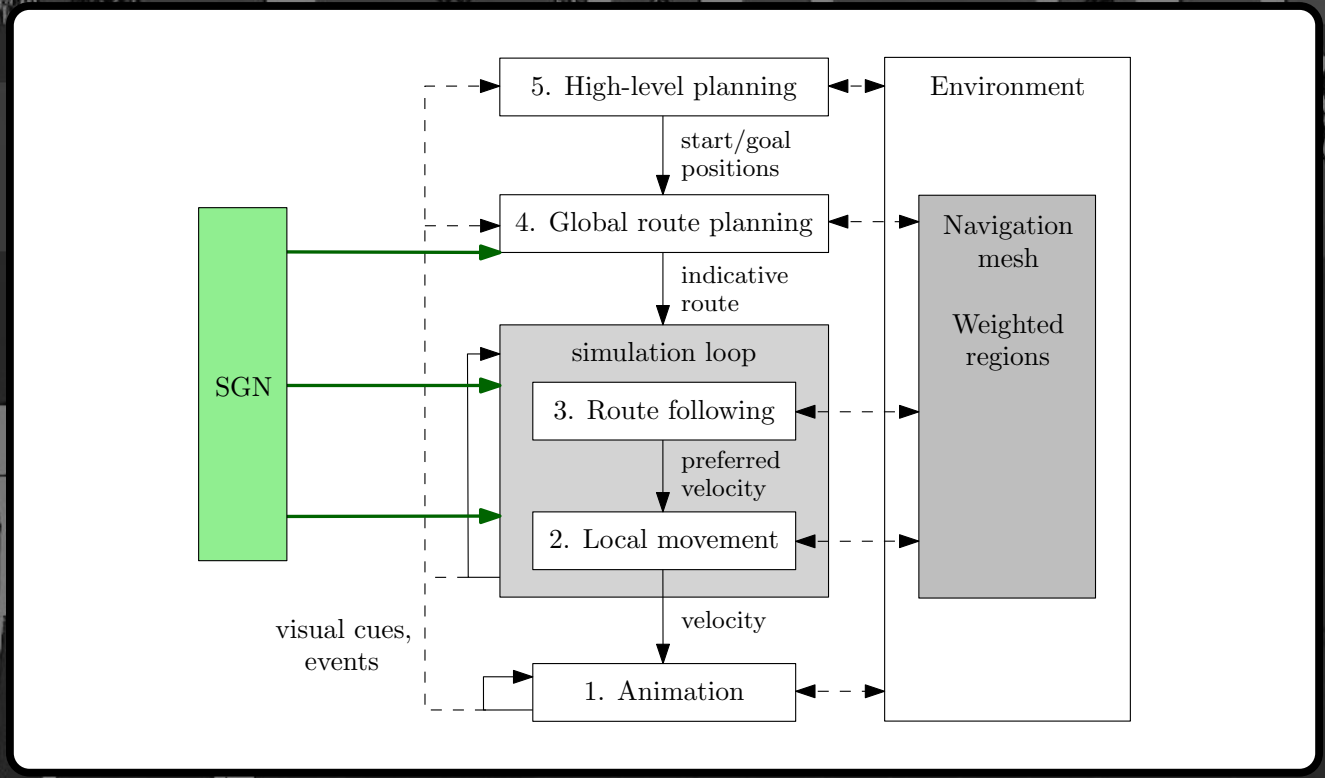
- either omit social formations
- or model them explicitly
- affect only local navigation planning



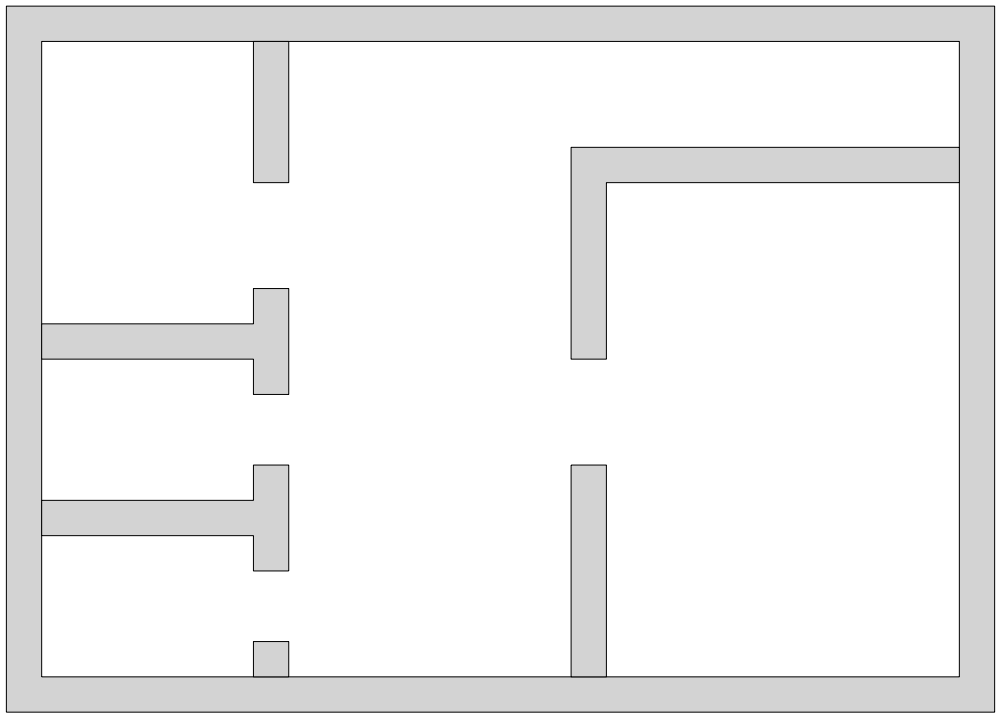
## Research Question

How can we generate emergent coherence and socially-friendly behavior on both global and local levels without explicitly modeling fixed formations?

# The *Social Groups and Navigation* (SGN) Method

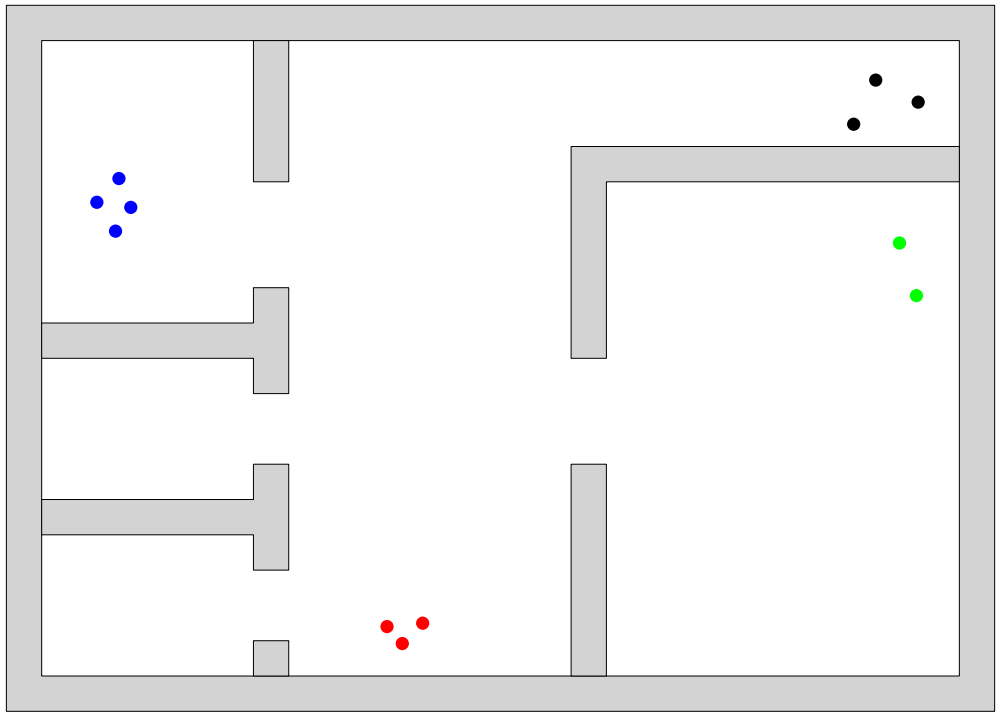


# Basic Settings and Initialization



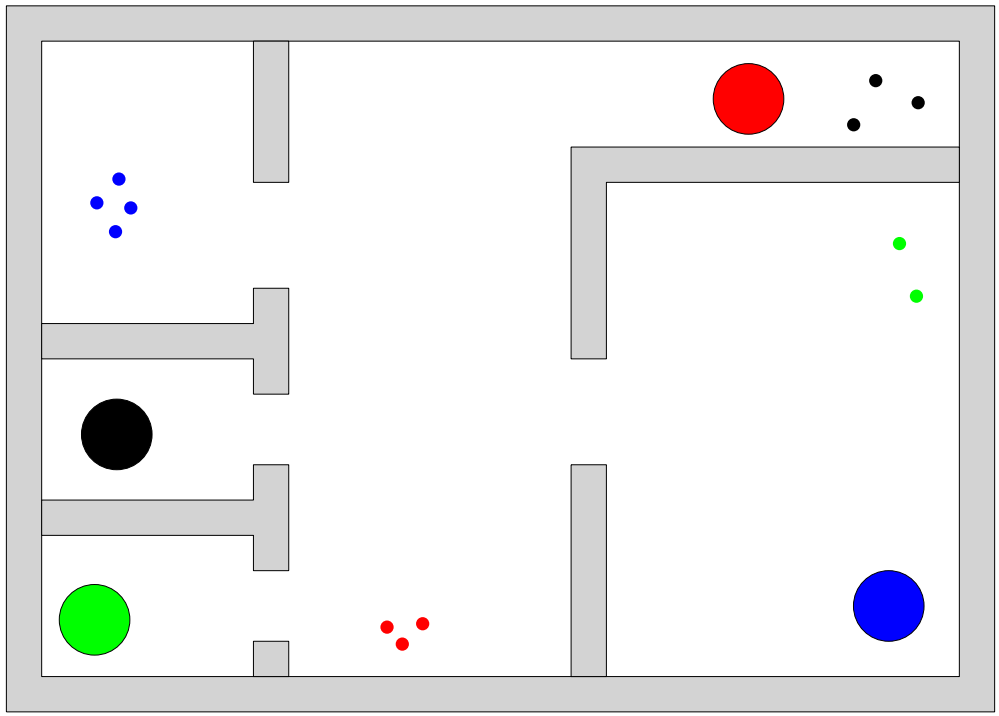
Input: An environment with obstacles...

# Basic Settings and Initialization



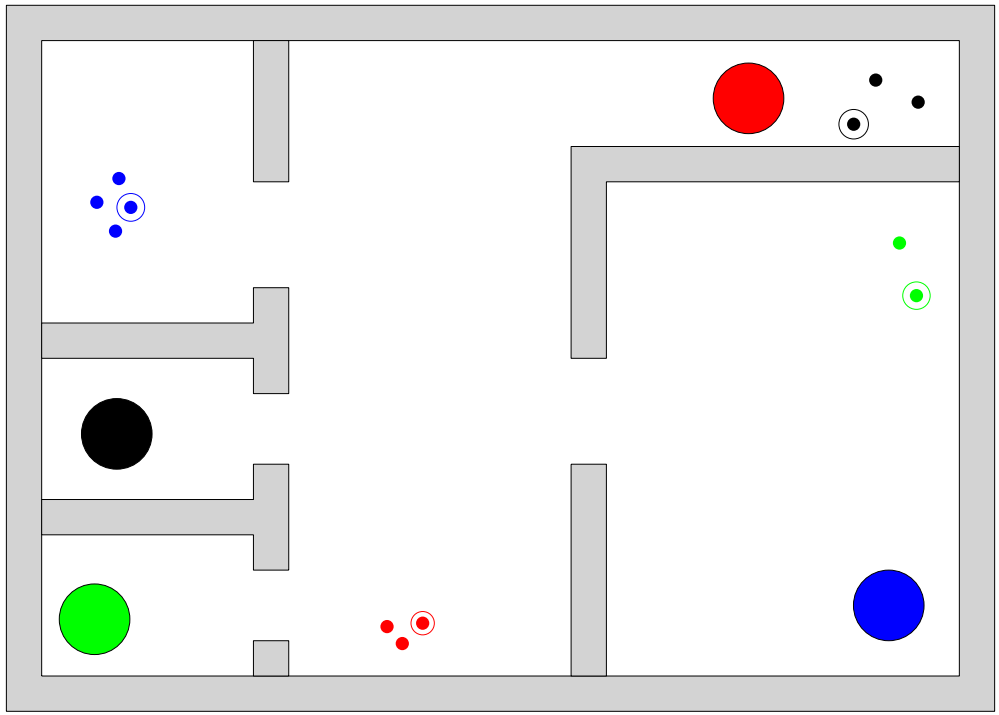
...and groups of agents...

# Basic Settings and Initialization



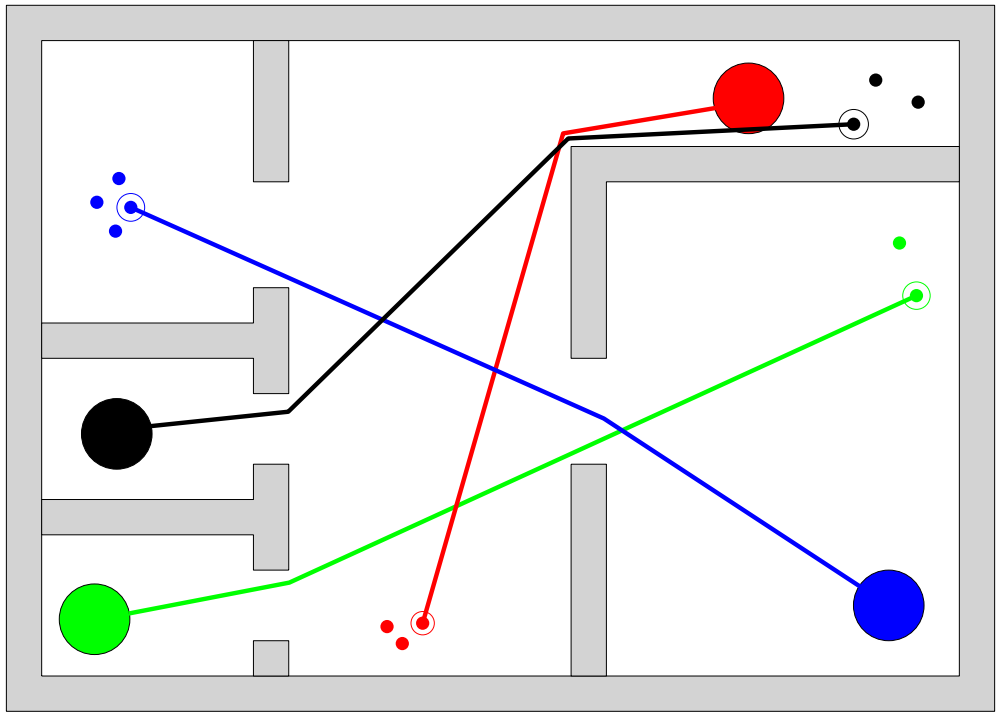
...with goal areas.

# Basic Settings and Initialization



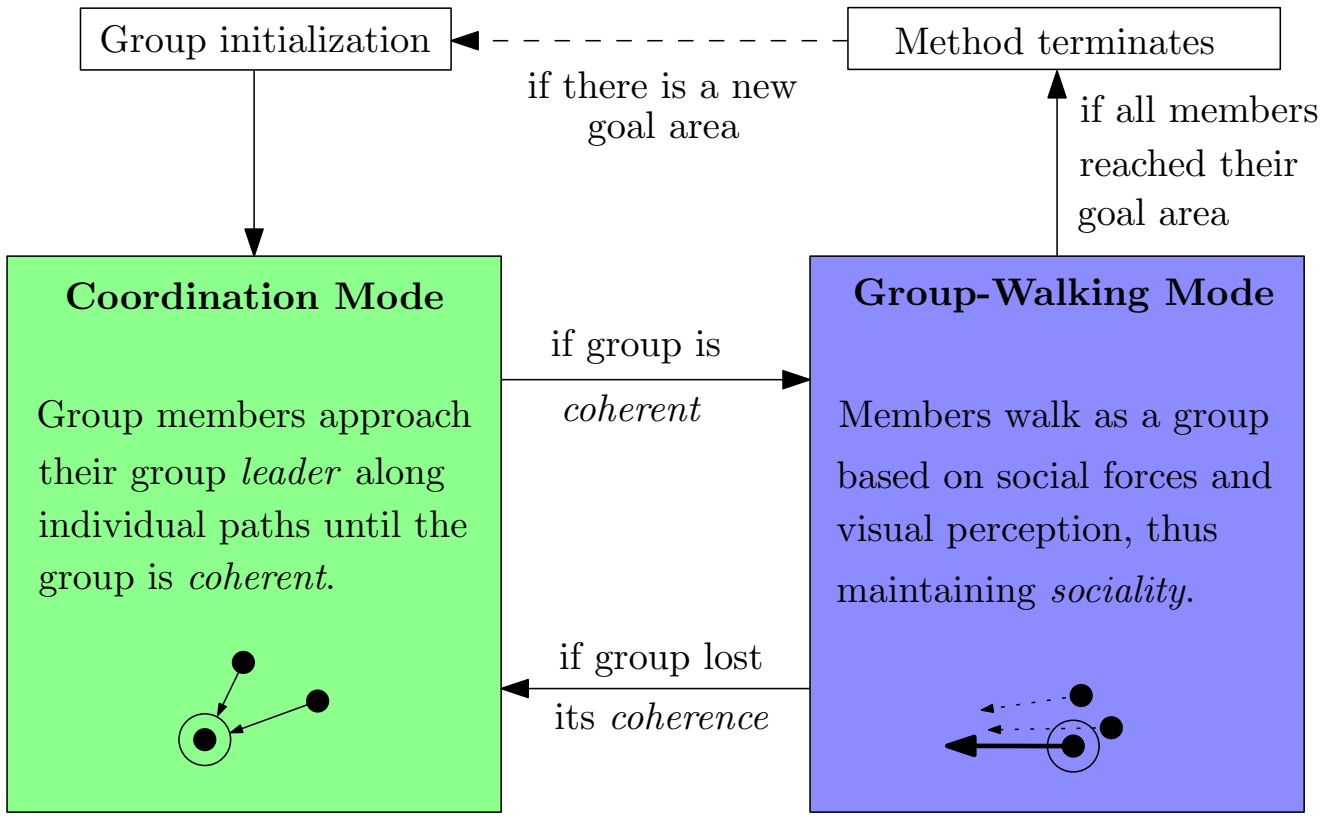
Assign a leader for each group randomly.

# Basic Settings and Initialization

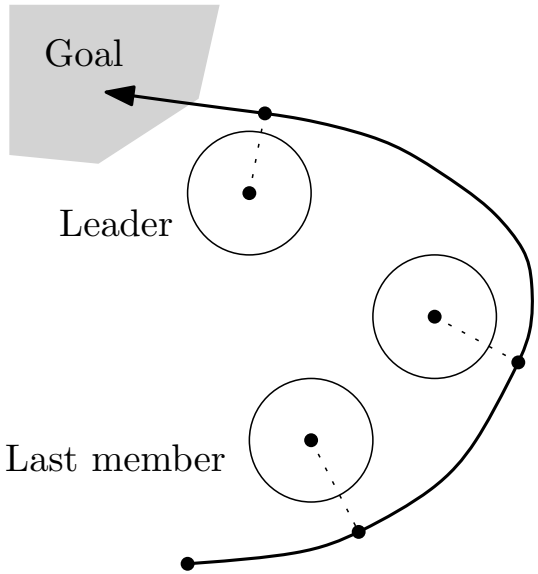


Compute shared global paths for leaders.

# SGN Overview

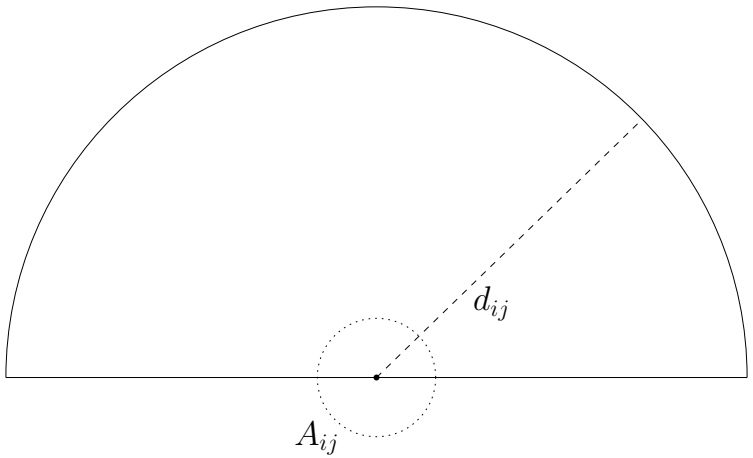


# Leader and Last Member




Based on the curve-length distance along the global path.

# Visual Perception: Field of View




Visibility distance $d_{ij}$ for agent $A_{ij}$ (the $j$th member of the $i$th group).

# Two Quantitative Metrics

## Coherence

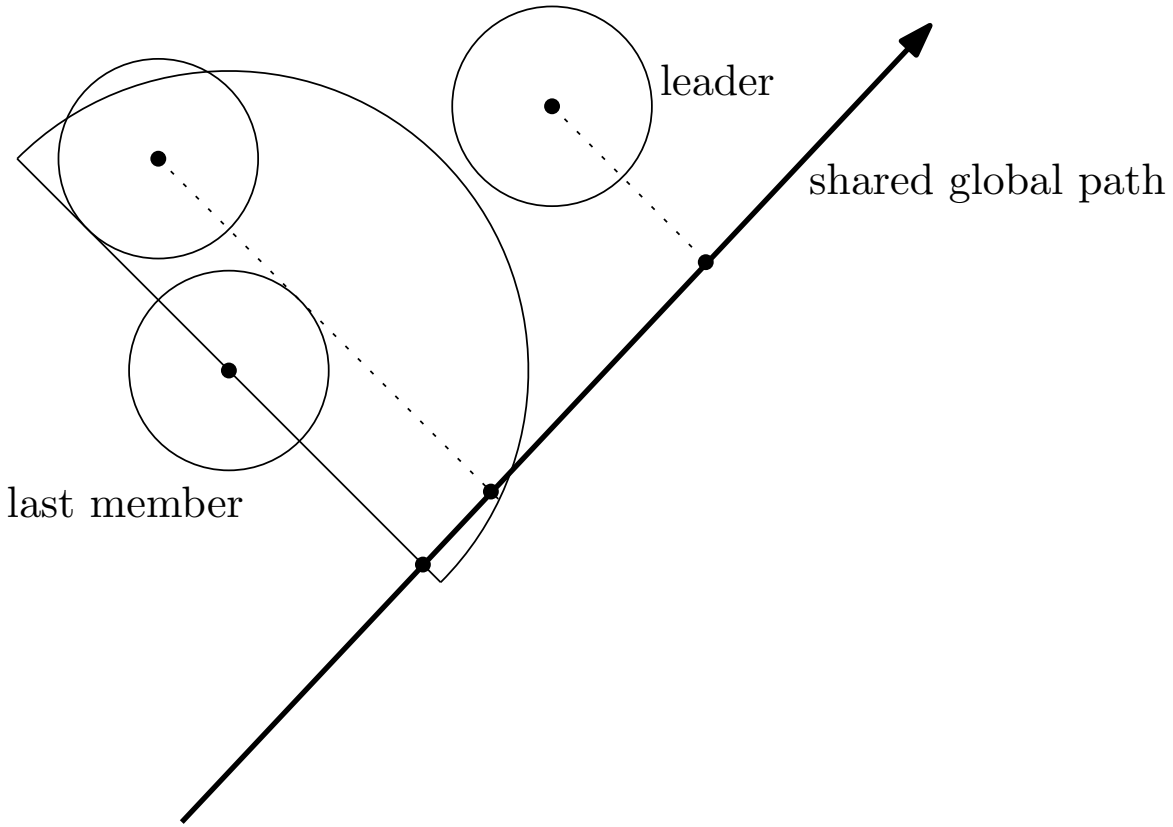
A group is *coherent* $\Leftrightarrow$ leader is in visible distance of the last member.

## Sociality

A group is *partially social* $\Leftrightarrow$ each member has at least one mutually visible other member within a *social threshold distance* $d_{social}$.

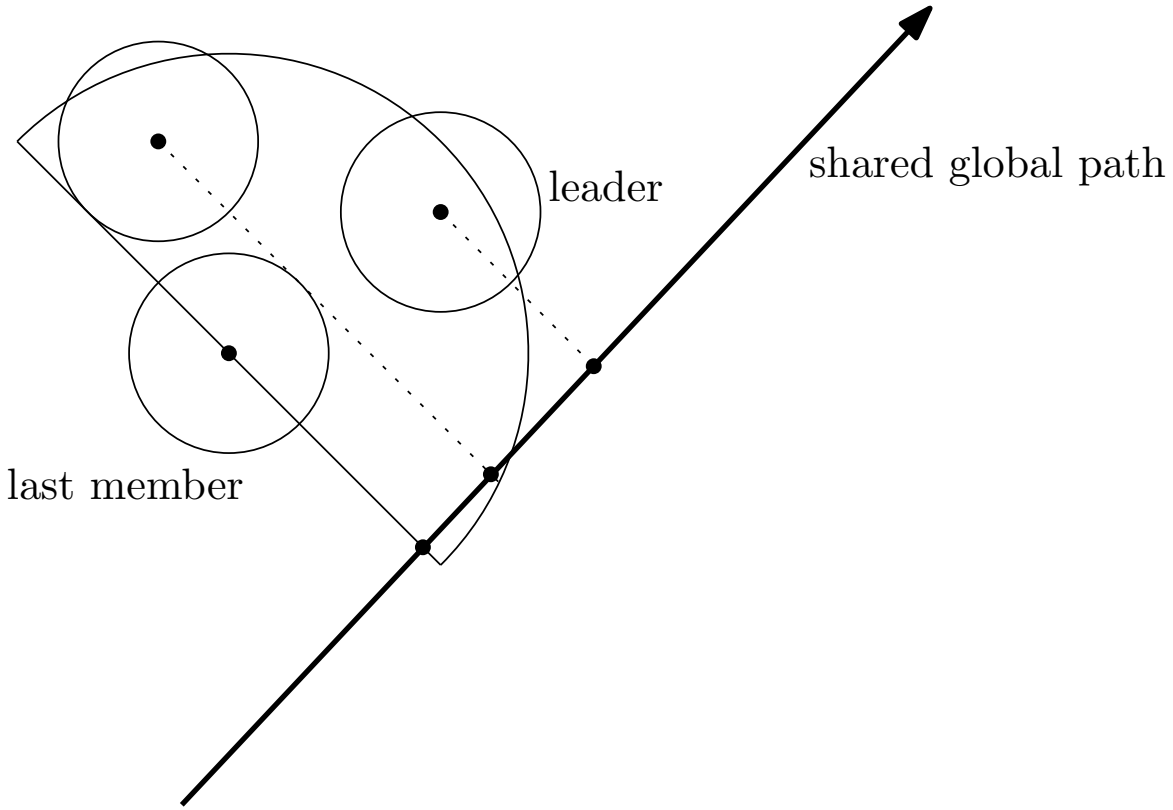
A group is *totally social* $\Leftrightarrow$ it is partially social and all members are mutually visible.

# Example Configurations



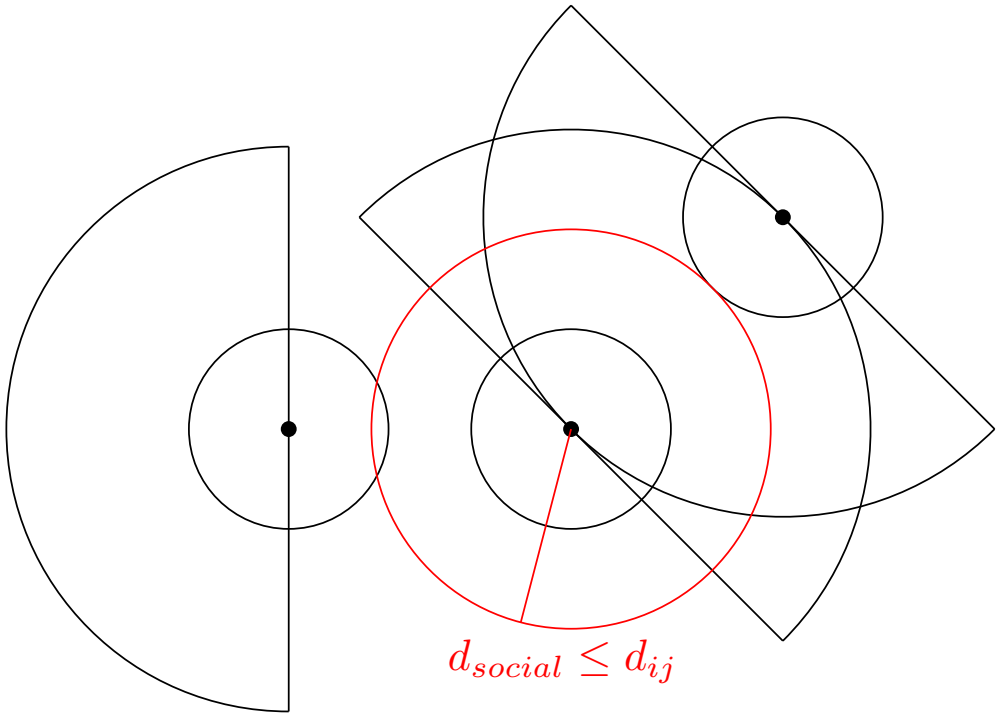

Not coherent

# Example Configurations



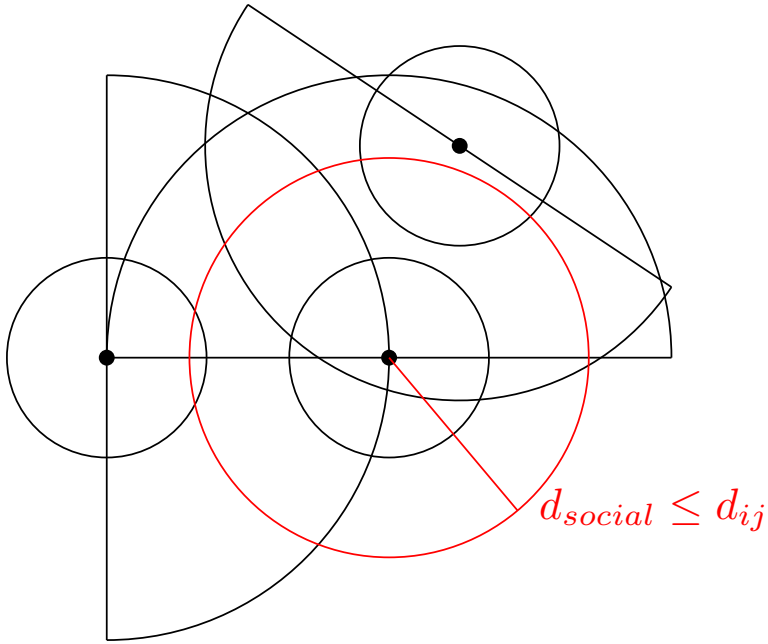

Coherent

# Example Configurations



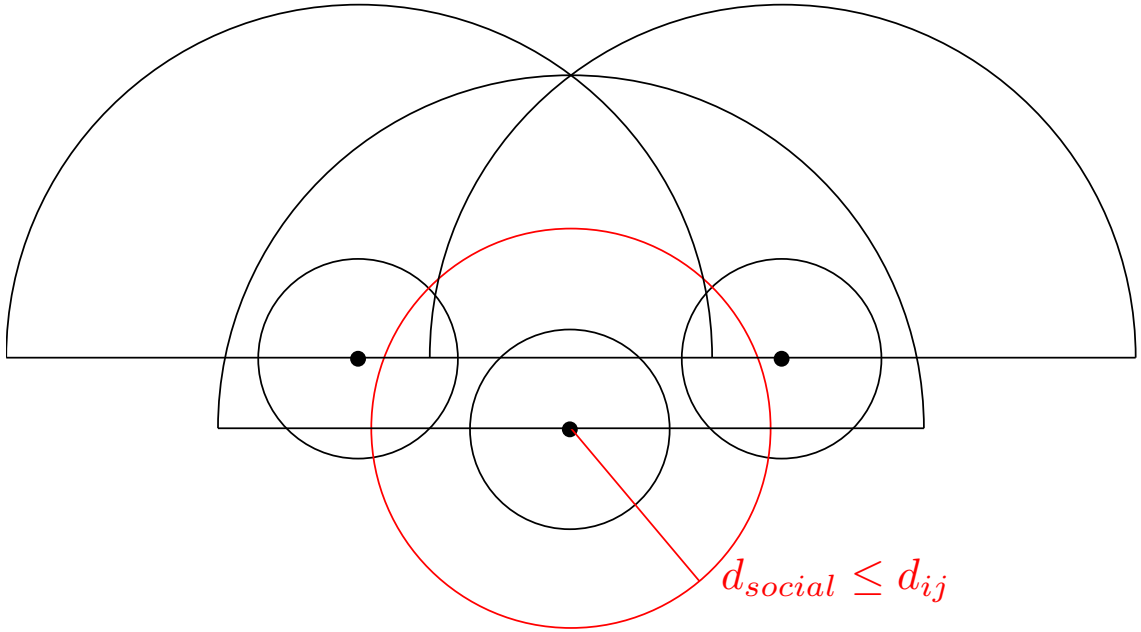

Not social

# Example Configurations




Partially social

# Example Configurations



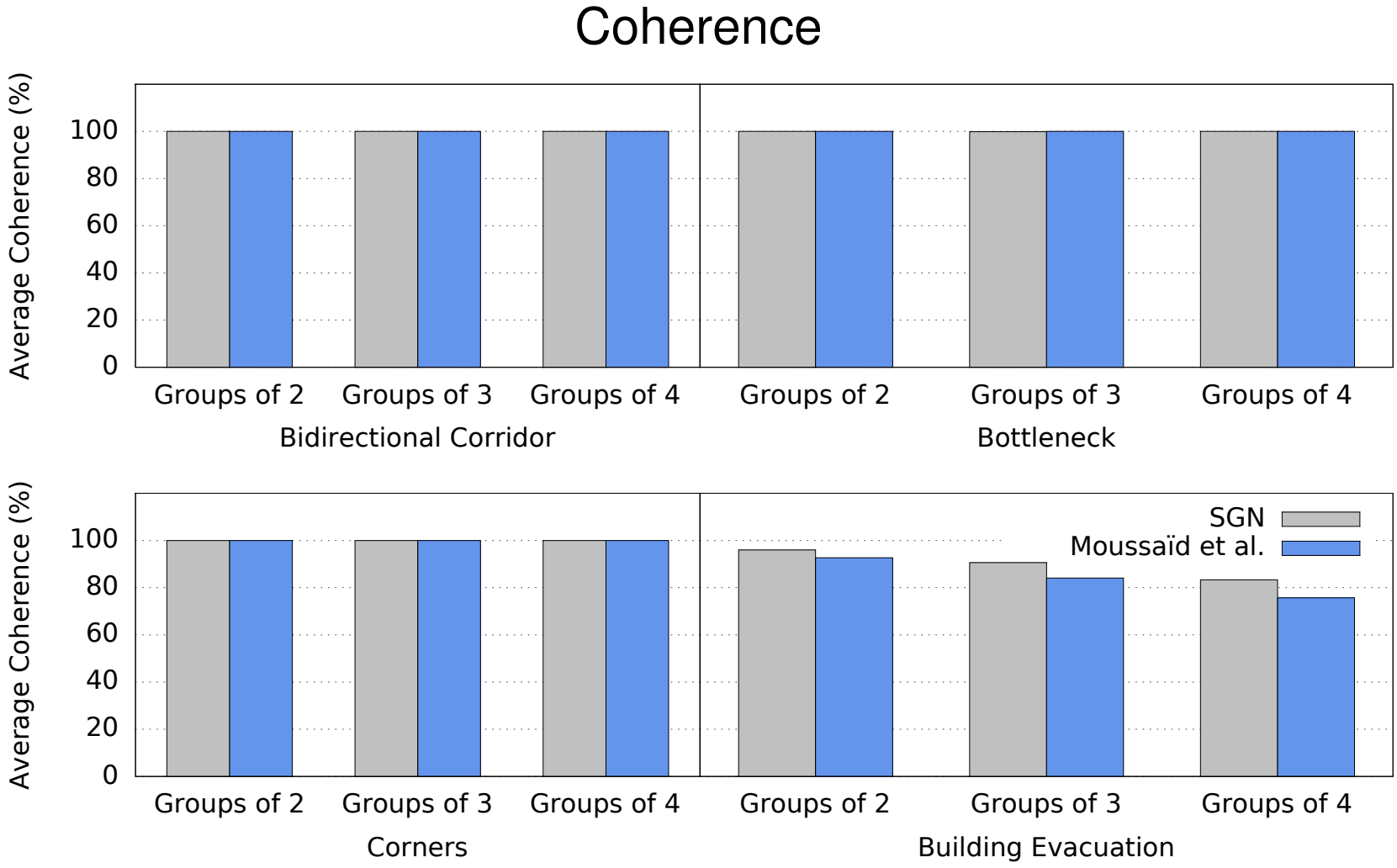

Totally social

# Social Forces

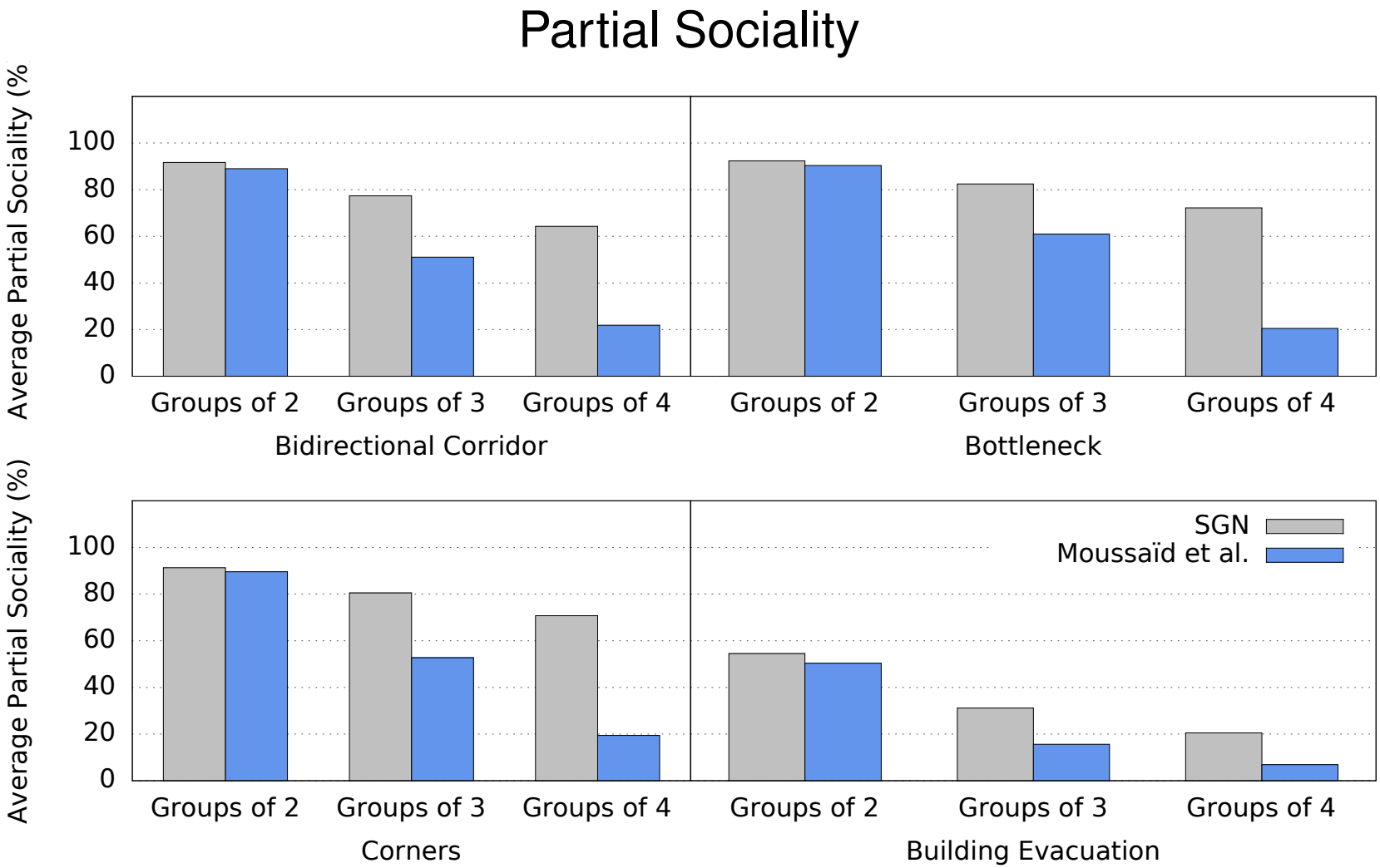
- Compute an agent's acceleration in each simulation step
- Social-force model based on Moussaïd et al. 2010[1], with modifications:
  - Physical-contact forces with other agents
  - Physical-contact forces with obstacles
  - Group force: $f_{vis} + f_{att}$
  - $f_{vis}$: each agent rotates so that its fellow members are visible
  - $f_{att}$: each agent is attracted towards the centroid of the group

[1] Moussaïd, Perozo, Garnier, Helbing, and Theraulaz. The walking behavior of pedestrian social groups and its impact on crowd dynamics. PLoS ONE 5, 4, e10047. 2010.

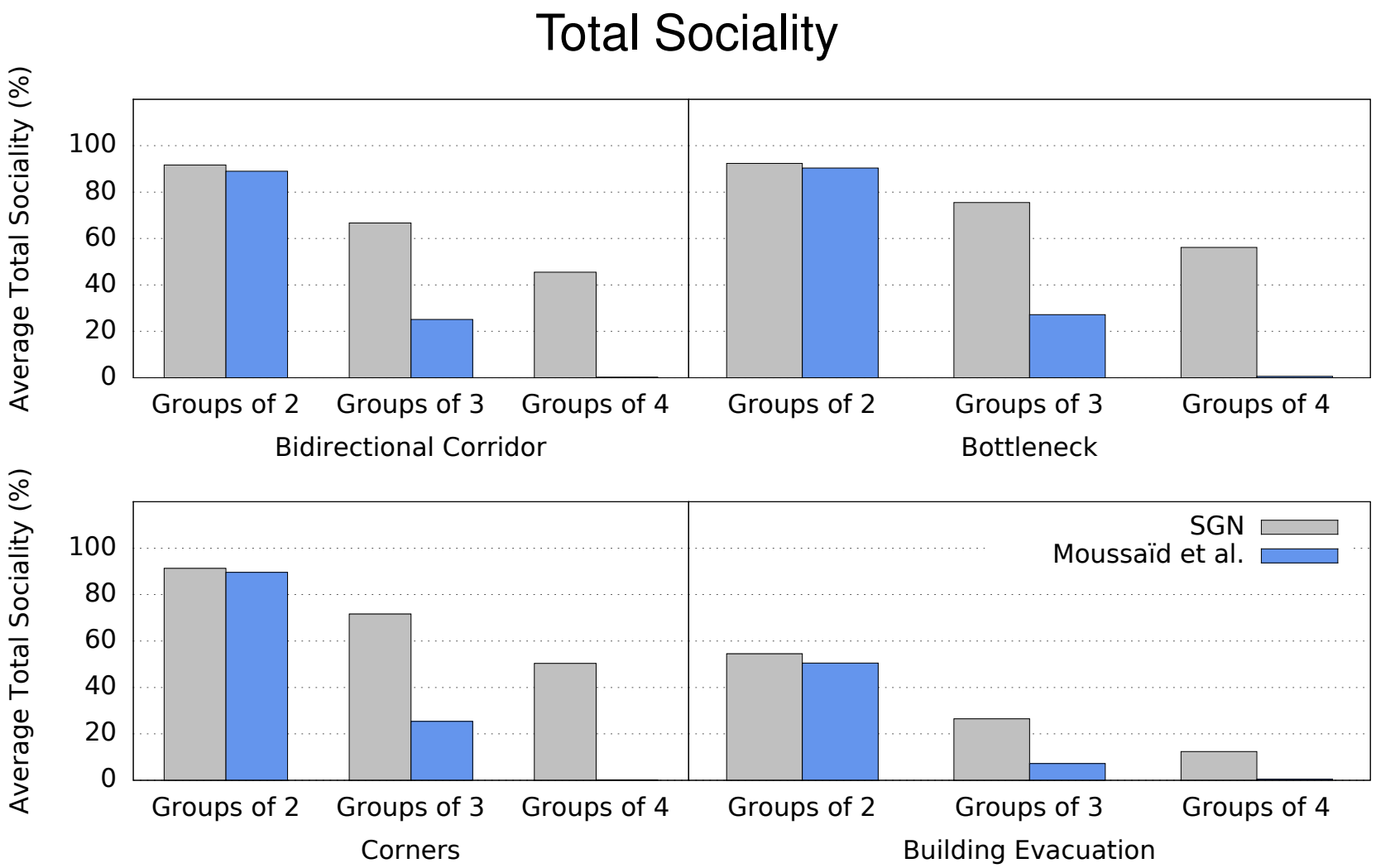
# Experimental Results



# Experimental Results

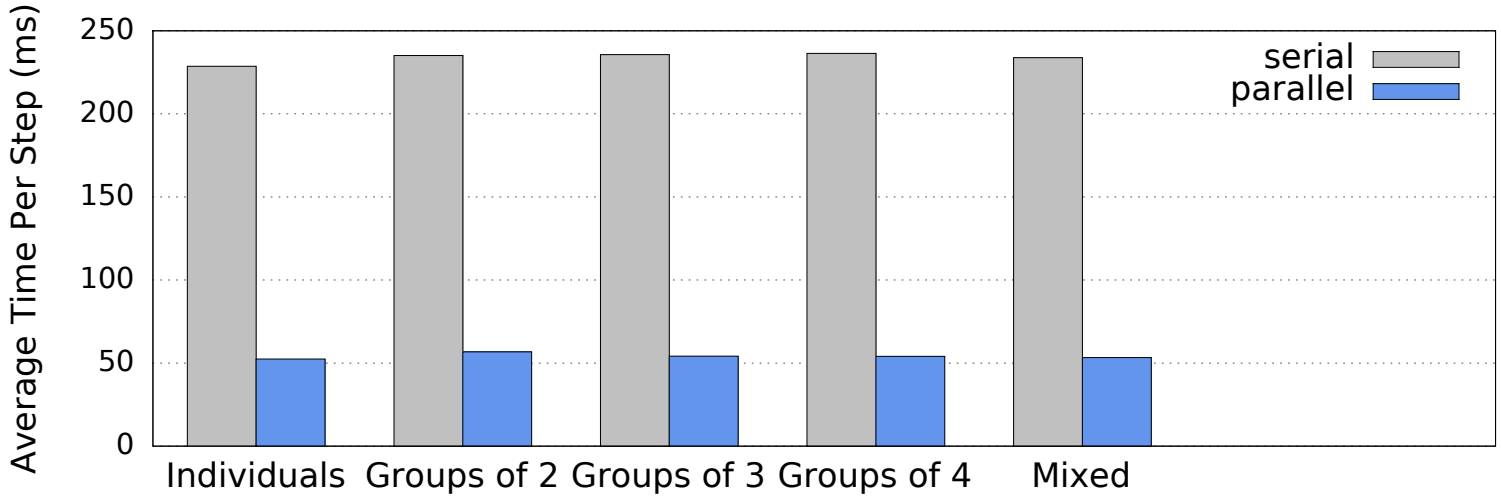


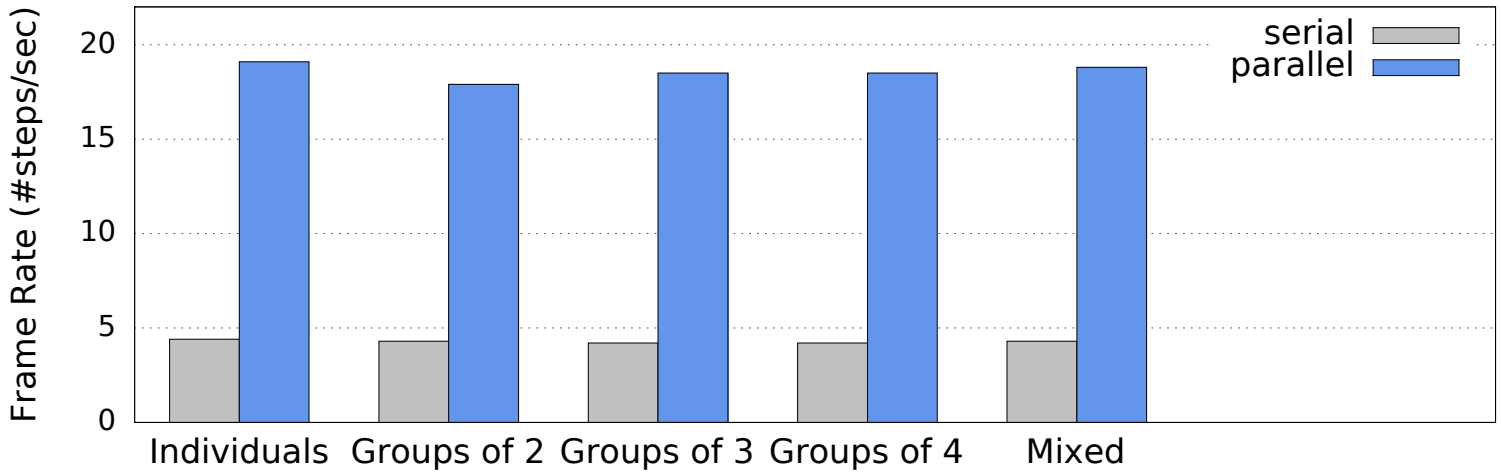
# Experimental Results



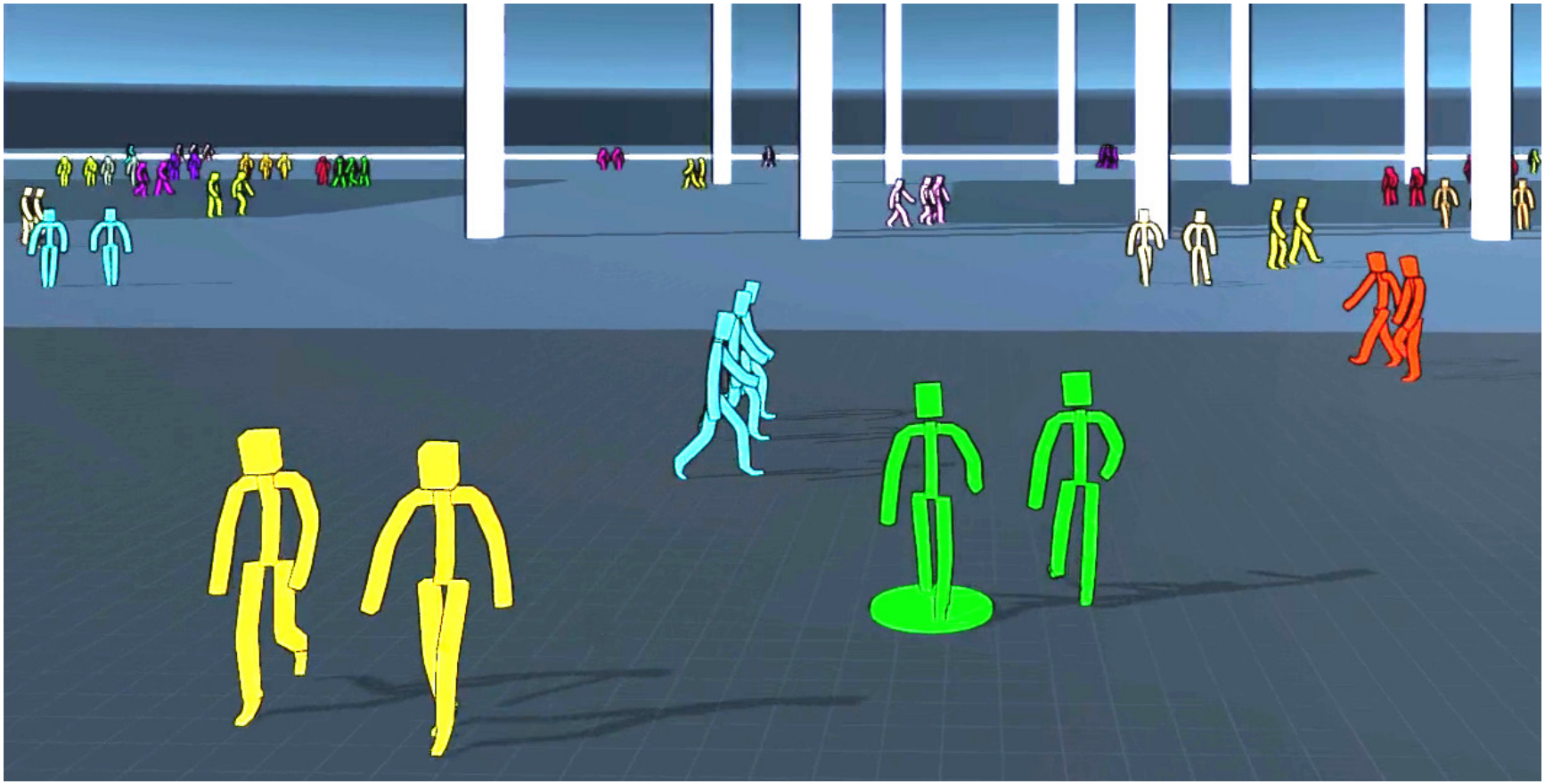
# Experimental Results

## Real-Time Performance



# Results: Video



# Conclusion

- SGN is based on the social-force model by Moussaïd et al 2010.
- SGN introduces social-group behavior on global and local levels.
- SGN yields emergent coherence and socially-friendly formations without explicitly modeling fixed formations.
- SGN can simulate several thousands of agents in real-time when run in parallel.
- SGN can be used in any crowd-simulation framework that handles global path planning and local path following separately.

## Future Work

- Extended validation:
  - Comparison with more existing work
  - Comparison with more real-life data
- Long-range visual perception rather than short-range field of view
- Combination with other existing work such as our *Stream* model for coordinating dense crowds


Thank you for your attention!
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