Simulating Crowd Behaviour

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Introduction

[1]

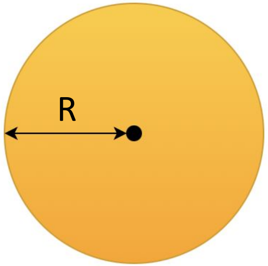
Aims

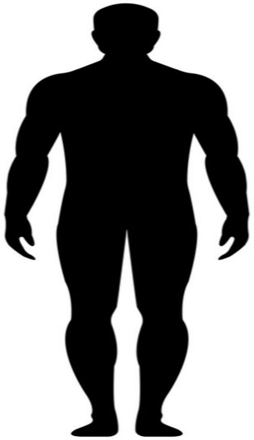
DEVELOP MODELS

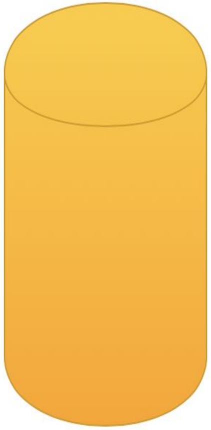
ANALYSE

SUGGEST

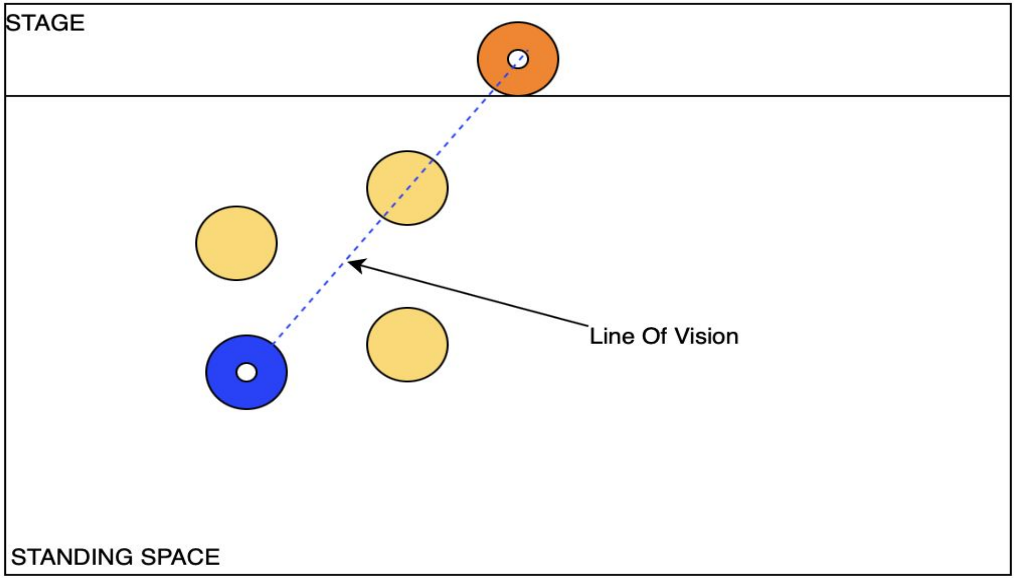
Modelling Agents

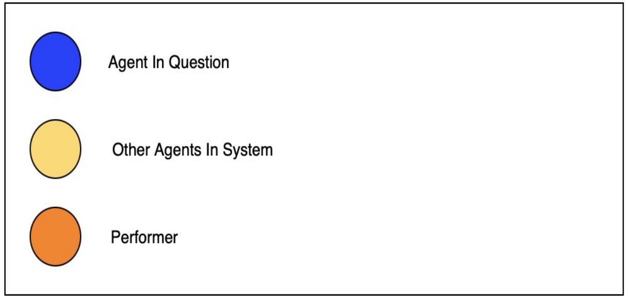






Modelling Vision (1)

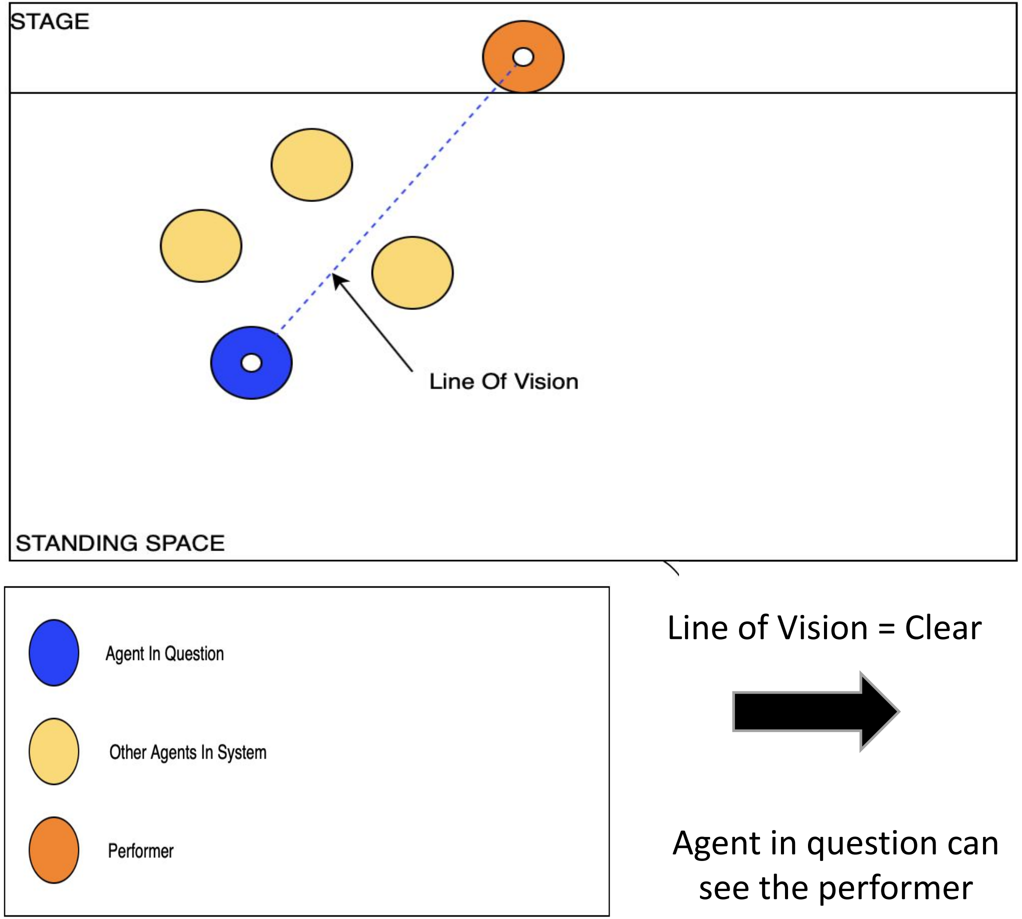




Line of Vision = Blocked

Agent in question cannot see the performer

Modelling Vision (2)



Line of Vision = Clear

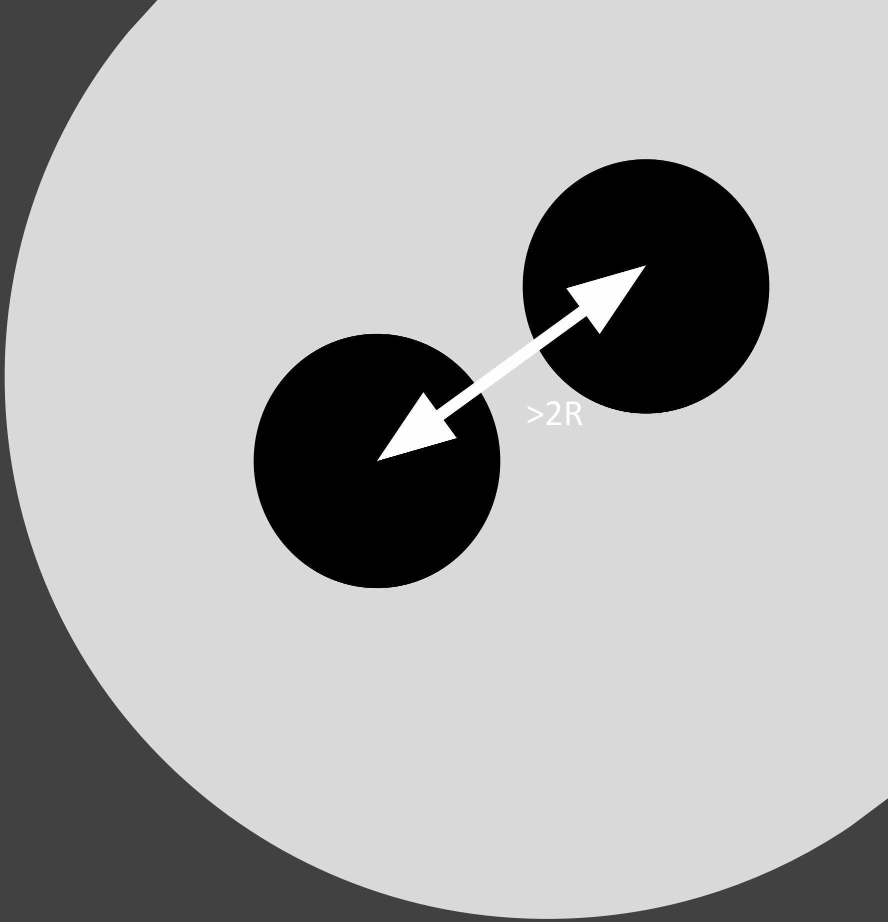
Agent in question can see the performer

Discrete Model

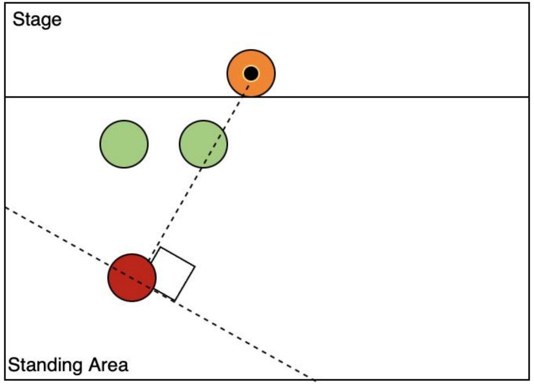
Random Distribution
Of Agents

Visibility Check

Movement

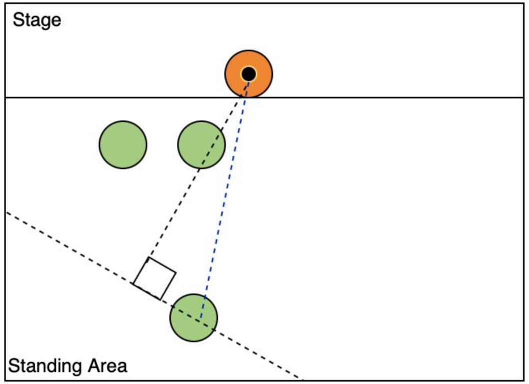


Modelling Movement - Discrete Model



Red = Obstructed Line of Vision

Move Randomly (L or R) in direction perpendicular to line of vision



Green = Unobstructed Line of Vision

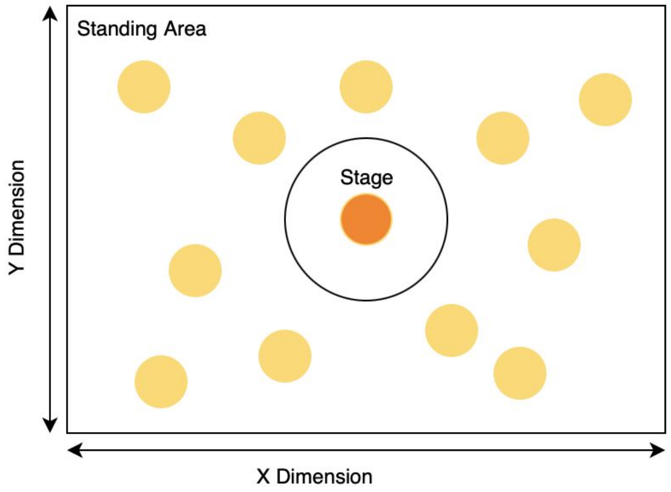
Remain Stationary!

Results…

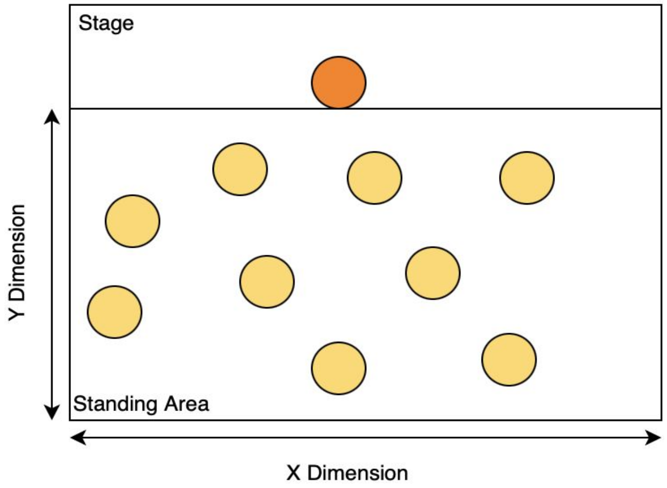
DENSITY

=

$$\frac{N(number\ of\ agents)}{STANDING\ SPACE\ AREA}$$



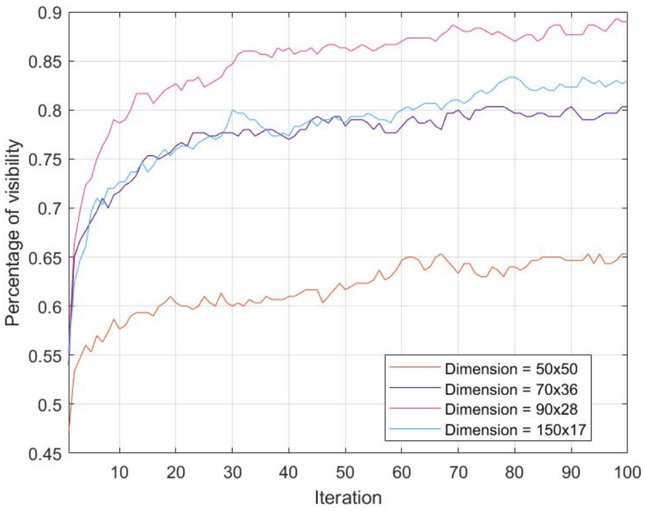
Circular Stage



Rectangular stage

The Effect of Standing Area Dimensions on Visibility

Rectangular Stage



longer X dimension (up to a threshold)

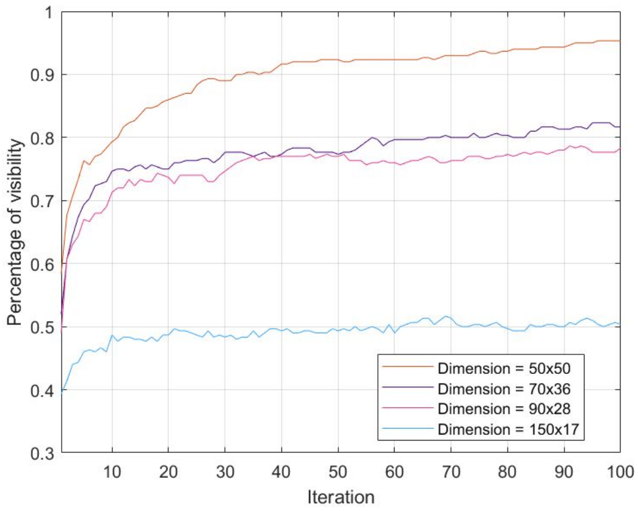
□

larger visibility

N=300

R=0.15m

Circular Stage



‘close’ to square shaped areas

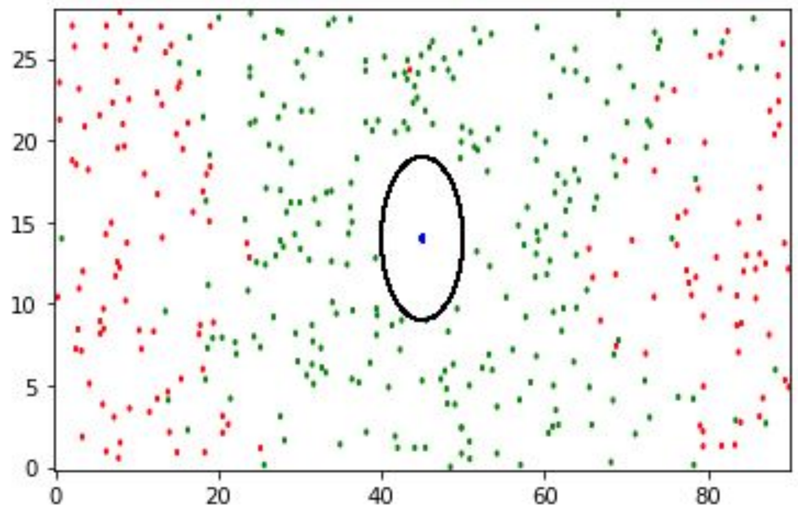
□

larger visibility

- **aspect ratio>2.5□ rectangular stage**
- **‘Close’ to square shaped venue □ circular stage**

Circular stage results explanation

Rectangle



agents near the sides of the smaller dimension

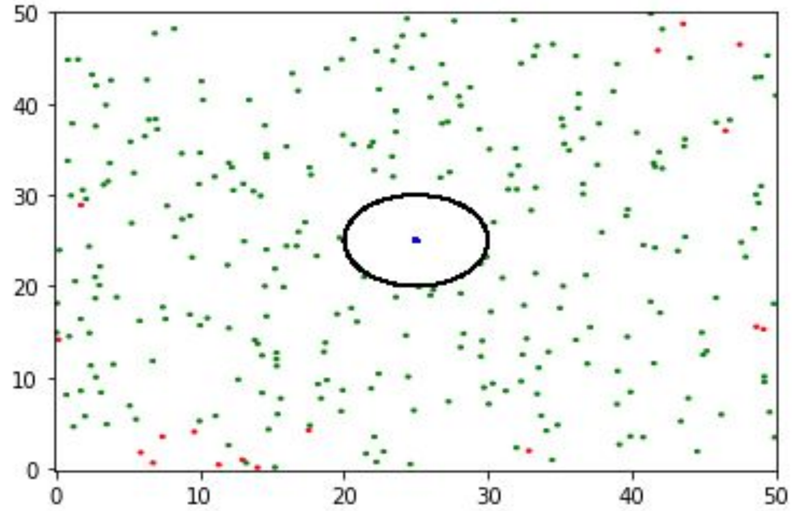
□

many columns of agents ahead (along the larger dimension)

□

visibility decreases

Square



square shape

□

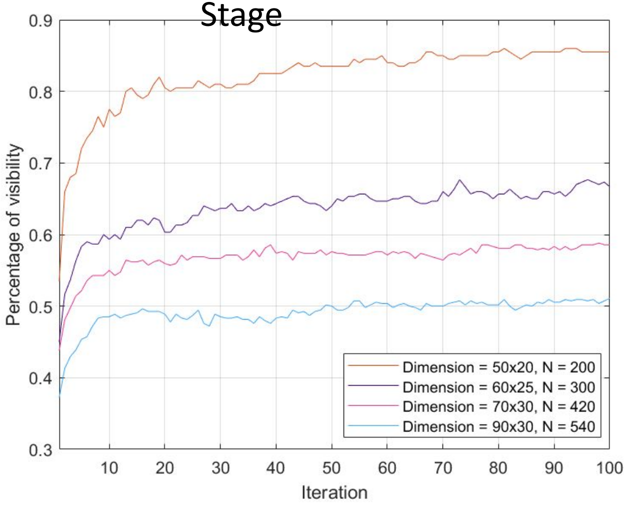
fewer columns of agents

□

higher visibility

The Effect of Standing Area on Visibility with Constant Density

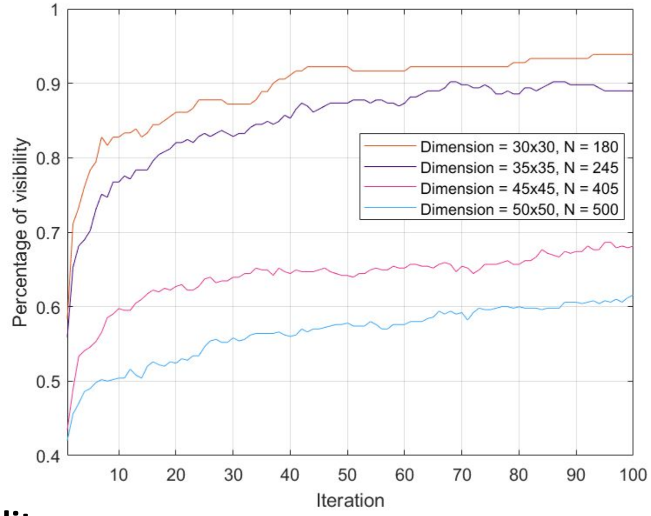
Rectangular Stage



Density = 0.2

R = 0.15m

Circular Stage



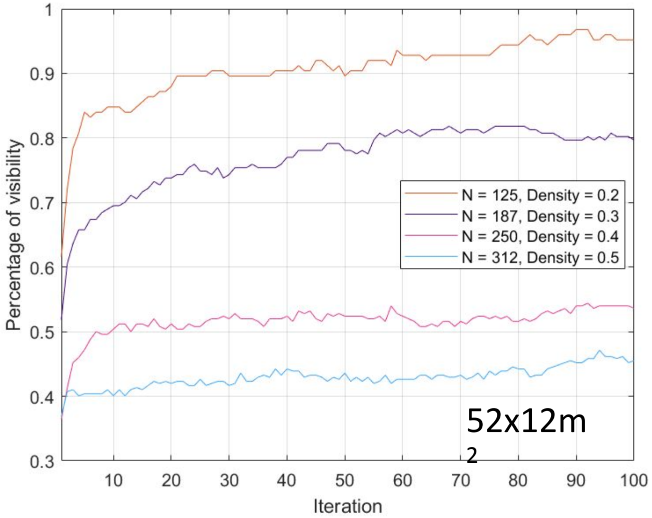
- **same density ≠ same visibility**
- **smaller area with same density**

□

increase in visibility

The Effect of Agent Density on Visibility with Constant Standing Area

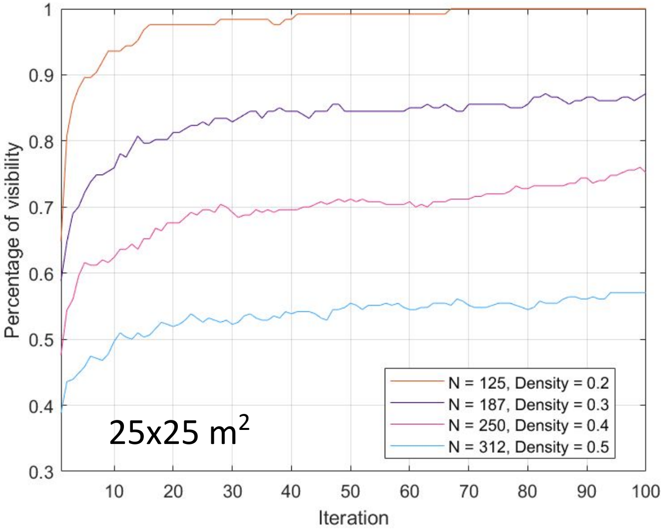
Rectangular Stage



52x12m 2

R = 0.15m

Circular Stage

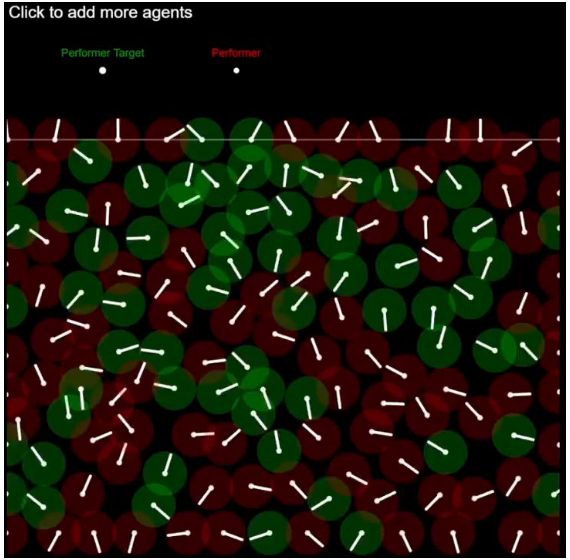


$25x25\ m^2$

Circular stage achieves higher visibility for the same density

Continuous Model

- Autonomous Nature
- ‘Boids’ Algorithm
- Separation and Seek Behavior
- Models Scenarios:
  - Moving Performer
  - Alternate Agent Desire



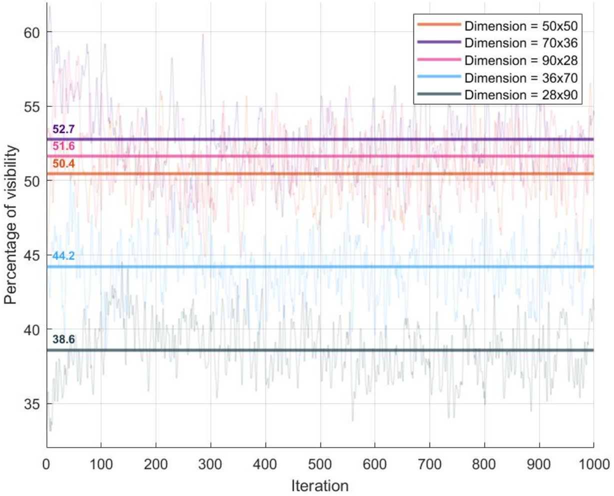
This video shows the continuous model with parameters:
- Density = 1 (full capacity)
- Dimension = 50x50

* The white lines represent agent’s velocity, not line of sight.

[2]

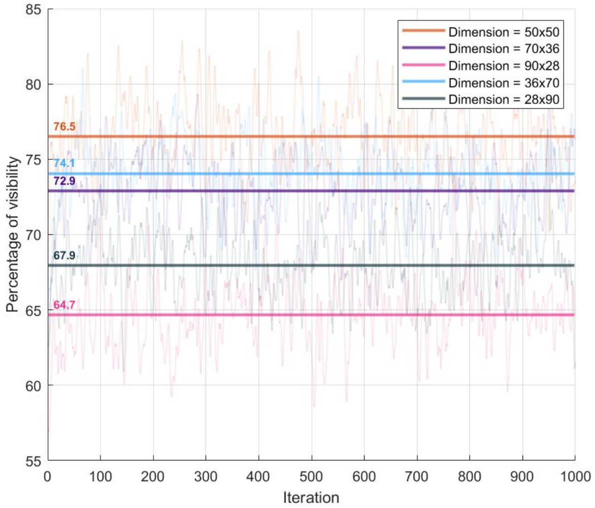
The Effect of Standing Area Dimensions on Visibility for a Stationary Performer

Rectangular Stage



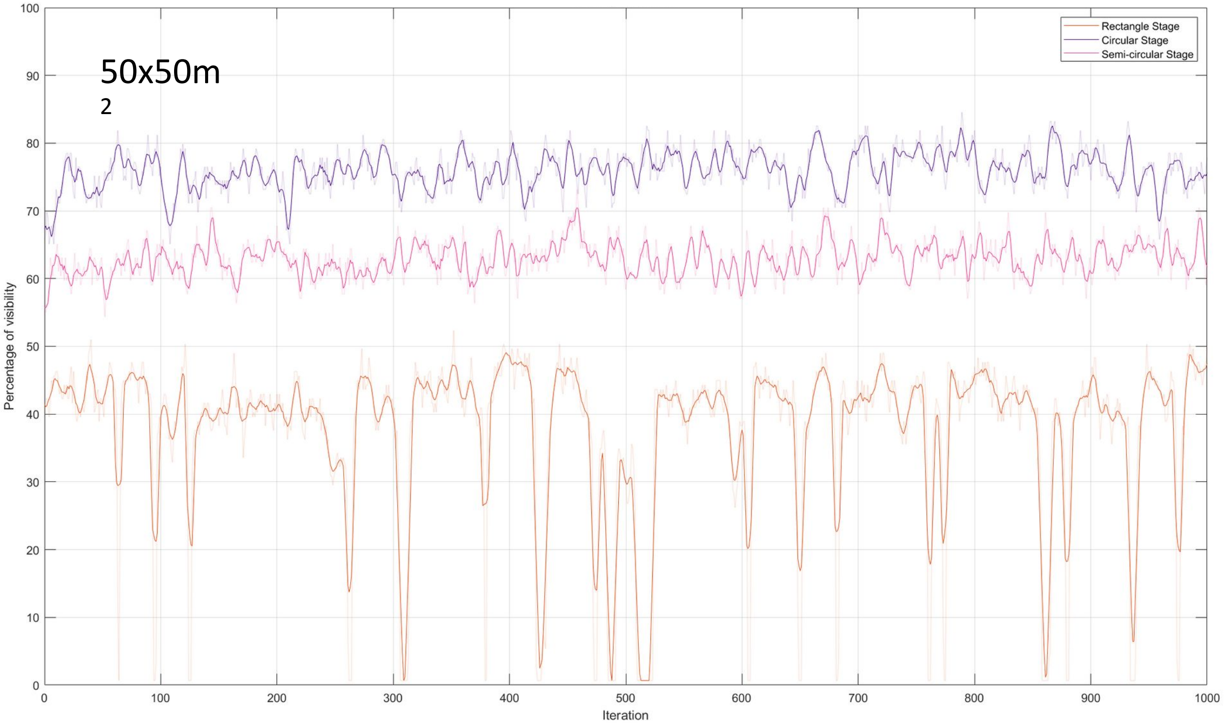
Density = 1
(full capacity)

Circular Stage



*Graphs show mean visibility (horizontal lines). Translucent lines represent raw visibility data.

Comparing the Visibility for a Moving Performer

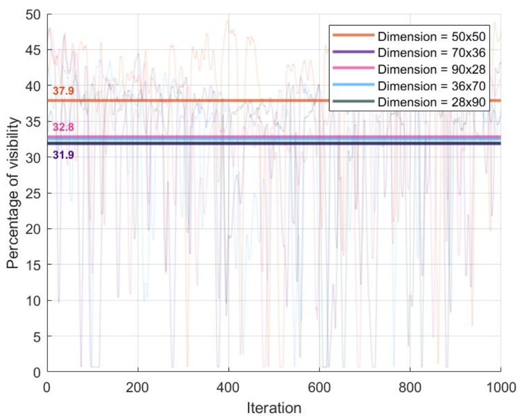


*Graph shows smoothed visibility. Translucent lines represent raw visibility data.

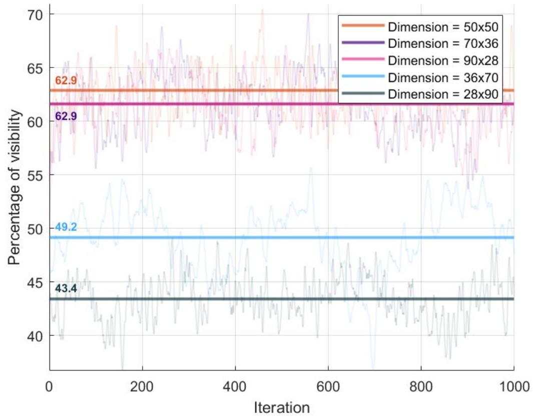
Density = 1 (full capacity)

The Effect of Standing Area Dimensions on Visibility for a Moving Performer

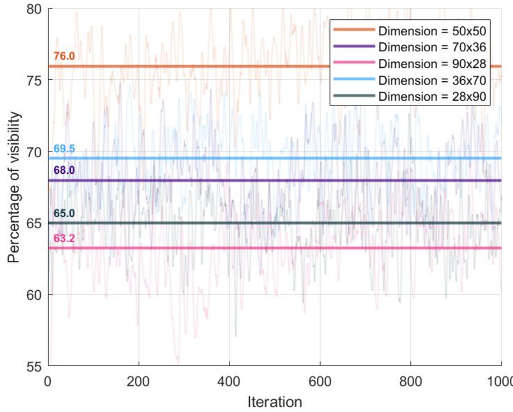
Rectangular Stage



Semi-circular Stage



Circular



*Graphs show mean visibility (horizontal lines). Translucent lines represent raw visibility data.

Density = 1 (full capacity)

Suggestions – Experimental Data

- Method=Motion Capture Helmets
- Pioneered by William Warren
- Can be used to verify results

[3]

Conclusion

- uniform width, height □ not realistic results but good initial approximation
- dependency of the alternative suggestions on the relevant parameters
- models different by design but fairly similar results □ validity of results

Limitation/further improvements

- different heights and widths with statistical distribution
- discrete model: comparison of different modeling of movement of agents with no visibility
- continuous model: more motivating factors, e.g., sticking to groups, or increasing number of performers
- experiments with more values of parameters computational complexity

References

[1] João E. Almeida, Crowd Simulation Modelling Applied to Emergency and Evacuation Simulations using Multi-Agent Systems, 2013.

[2] Craig W. Reynolds, Steering Behaviors For Autonomous Characters, 1999.

[3] William Warren, Behavioral Dynamics of Heading Alignment in Pedestrian Following, 2014.