Crowd Simulation based on Self-consciousness Theory

Gayeon Lee

Advisor: Sung-Eui Yoon

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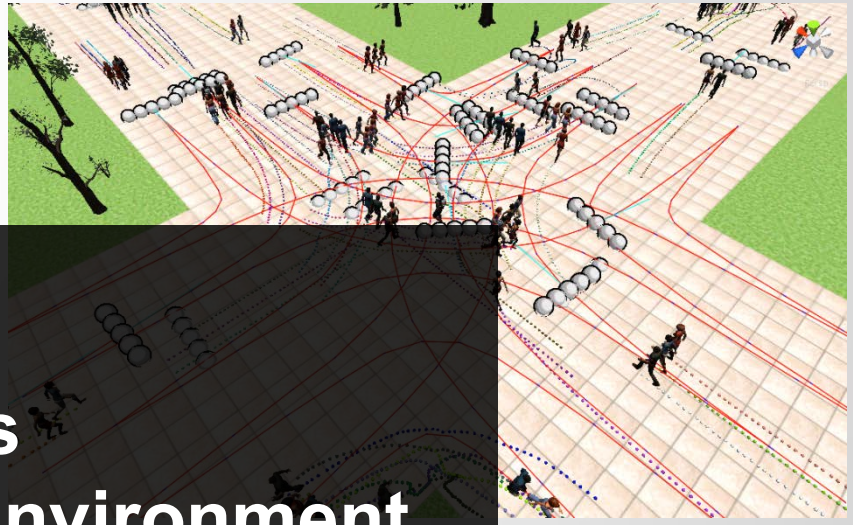
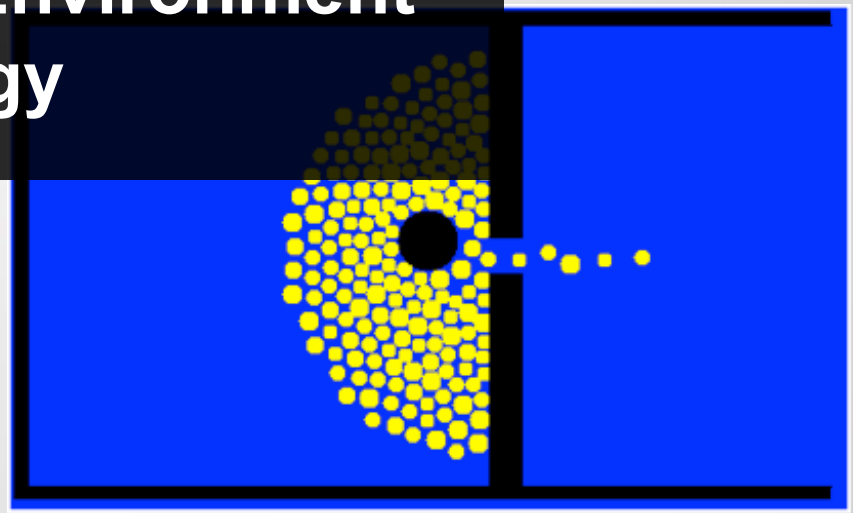
1. Background

Crowd Simulation





- Films
- Robotics
- Virtual Environment
- Sociology

1. Background

Crowd Simulation

- The process of simulating the movement of a large number of characters

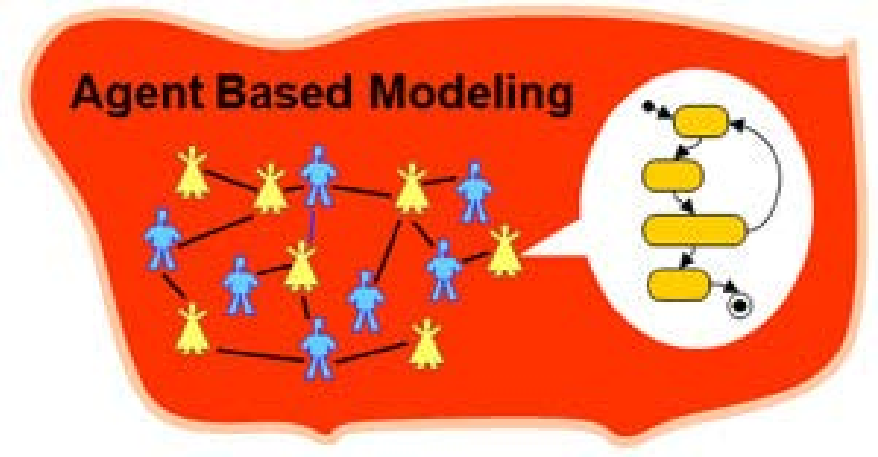
1. Particle Motion
   - Characters are attached to point particles

2. Agent based model
   - Agents are given artificial intelligence
     - Functions, sight, basic motion, energy level, etc.

1. Background

Agent based model

- Simulating the actions and interactions of autonomous agents
- Simple behavioral rules generate complex behavior
- Used in biology, ecology, and social science



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2. Related work

Planning

- Existing crowd simulation
  - Find a way to reach a global planning destination (**global planning**)
  - Avoid obstacles and other agents (**local planning**)

2. Related work

Planning

- The standard crowd simulation loop is as follows:

Global Planning

- **Find a path to the goal.** Set the preferred velocity along the direction of the initial segment of the path.

2. Related work

Global + Local Planning

- The standard crowd simulation loop is as follows:

Global Planning

- **Find a path to the goal**. Set the preferred velocity along the direction of the initial segment of the path.

Local collision avoidance

- Steer the preferred **velocity away from collision** with other agents, yielding the actual velocity that the agent moves with.

2. Related work

Planning + Psychology

1. *Simulating Heterogeneous Crowd Behaviors Using Personality Trait Theory [Stephen at el., SCA 2011]*

2. *How the Ocean Personality Model Affects the Perception of Crowds [Duruponar at el., CG&A 2011]*

3. *Interactive Simulation of Dynamic Crowd Behaviors using General Adaptation Syndrome Theory [Kim at el., I3D 2012]*

2. Related work

Planning + Psychology

1. *Simulating Heterogeneous Crowd Behaviors Using Personality Trait Theory [Stephen at el., SCA 2011]*

- Mapping **Personality trait theory** with RVO
  - Psychoticism, Extraversion, Neuroticism
  - Mapping among adjectives and **PEN** factors

Trait	Adjectives
Psychoticism	Aggressive, Impulsive
Extraversion	Assertive, Active
Neuroticism	Shy, Tense

2. Related work

Planning + Psychology

2. *How the Ocean Personality Model Affects the Perception of Crowds [Funda Duruponar at el., IEEE 2011]*

- Mapping the **Ocean Personality** with HiDAC
  - Openness
  - Conscientiousness
  - Extroversion
  - Agreeableness
  - Neuroticism

2. Related work

Planning + Psychology

3. *Interactive Simulation of Dynamic Crowd Behaviors using General Adaptation Syndrome Theory [Kim at el., I3D 2012]*

- Mapping **General Adaptation Syndrome** with RVO
  - Stressor Prototypes
    - Time pressure
    - Area stressors
    - Positional stressors
    - Interpersonal stressors

Contents

3. Overview

Observation

- In case of emergency, people don’t do anything to escape when neighbors don’t take an action
- A role of neighbors is important to others
- *Ex) Subway accident*

3. Overview

Limitation

- Other researches focus on personality of each agent.
- In the evacuation scene, every agent start to escape at the same time.

3. Overview

Our goal

- Simulate agent affected by behavior of other neighbors (whether other agents escape or not)
- Agent start to escape at different time
- Agent moves differently when it moves alone or has neighbors nearby it

3. Overview

Overview of our approach

- Integrate planning algorithm with psychological factor

3. Overview

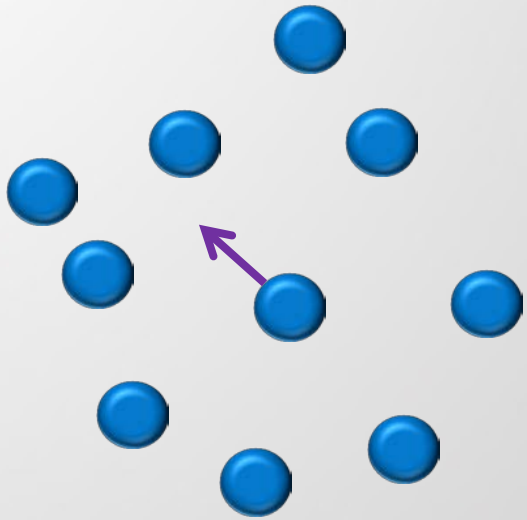
RVO library

- *[Reciprocal Velocity Obstacles for Real-Time Multi-Agent Navigation, Jur V D Berg at el., ICRA 2008]*
- Interactive navigation and planning of large numbers of agents
- Collision-free, Oscillation-free behavior

3. Overview

Parameter of RVO library

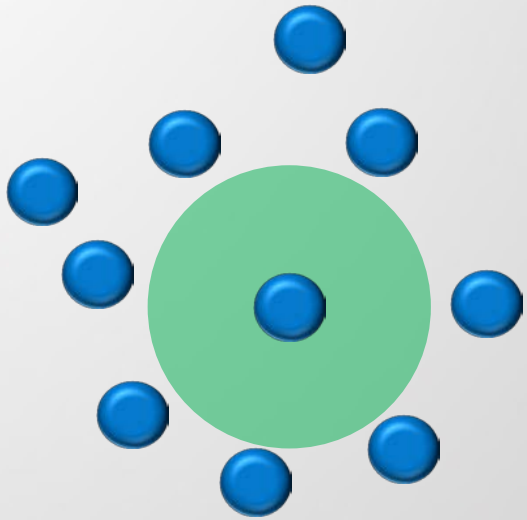
- Preferred speed



3. Overview

Parameter of RVO library

- Preferred speed
- Effective radius



3. Overview

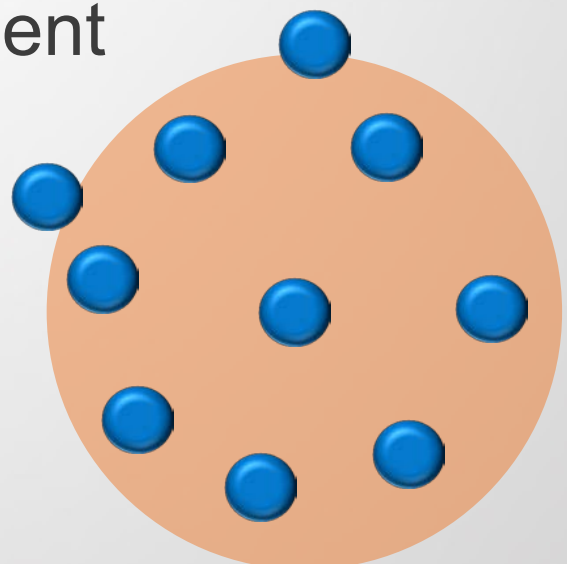
Parameter of RVO library

- Preferred speed
- Effective radius
- Maximum number of neighbors affecting the local behavior of an agent

3. Overview

Parameter of RVO library

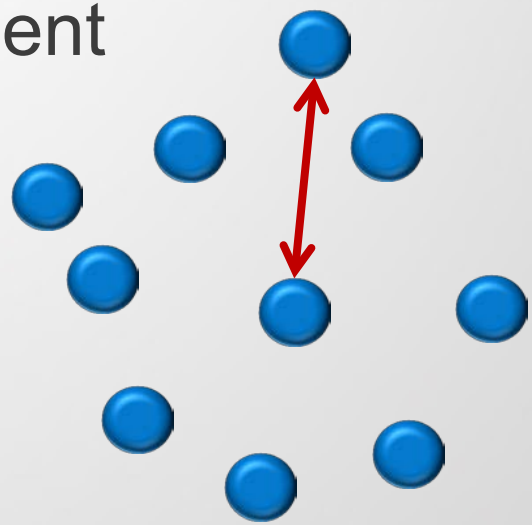
- Preferred speed
- Effective radius
- Maximum number of neighbors affecting the local behavior of an agent
- Maximum distance of neighbors affecting the local behavior of an agent



3. Overview

Parameter of RVO library

- Preferred speed
- Effective radius
- Maximum number of neighbors affecting the local behavior of an agent
- Maximum distance of neighbors affecting the local behavior of an agent
- Planning horizon



3. Overview

Parameter of RVO library

- Preferred speed
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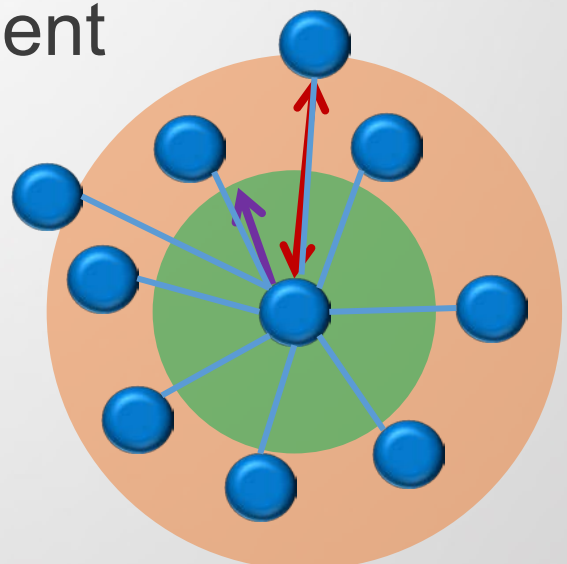


3. Overview

Self-consciousness Theory

- Public Self-consciousness
  - Tendency to focus on external environment or other people nearby
- Private Self-consciousness
  - Tendency to concentrate on one's inner self and feeling
- Social Anxiety
  - Discomfort or fear when a person is in a social interaction

Contents

4. Mapping

User study + Mapping

- Intuitive mapping
  - Participants choose tendency for each parameter compared to default value
    (bigger, similar, or smaller)

- Hand tuning mapping
  - Participants assign parameter values iteratively with observation.
  - Choose the scene when the scene is similar with they are expected.

4. Mapping

Intuitive modeling

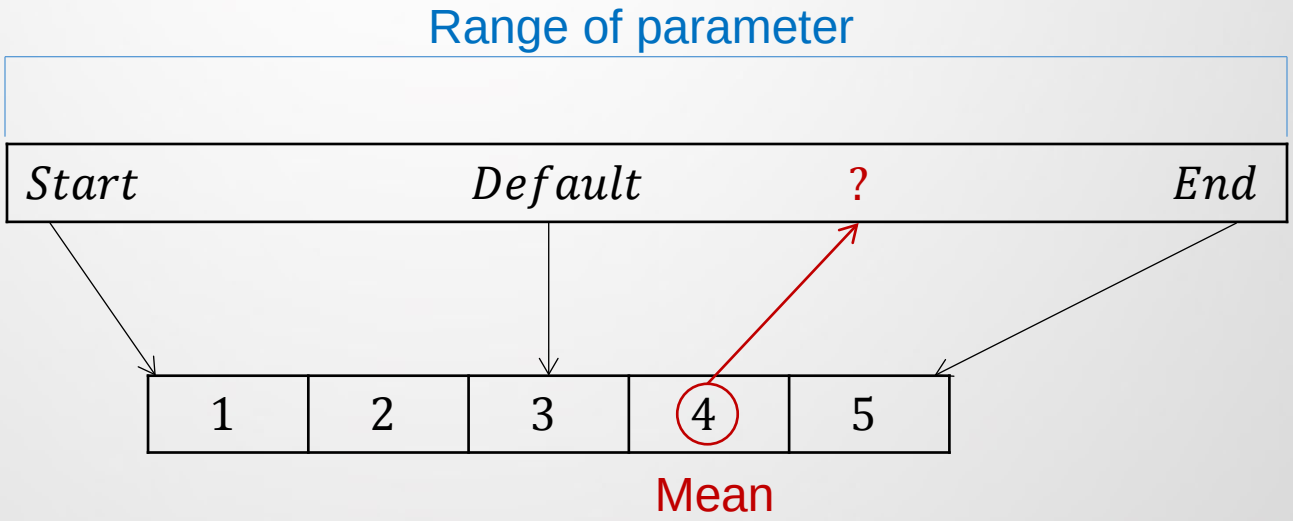
- Participants asked which parameter values are suitable for self-conscious agent compared to default agent (level 1 to 5)

Parameter	Default value	Range
neighborDist	15.0 m	3 – 30 m
maxNeighbors	10	1 – 50
timeHorizon	10.0 s	1 – 30 s
radius	2.0 m	0.3 - 2.5 m
maxSpeed	2.0 m/s	1.2 - 2.2 m/s
affectNeighbor	3	0 – 10
escapeProbability	0.4	0 – 1

4. Mapping

Intuitive mapping

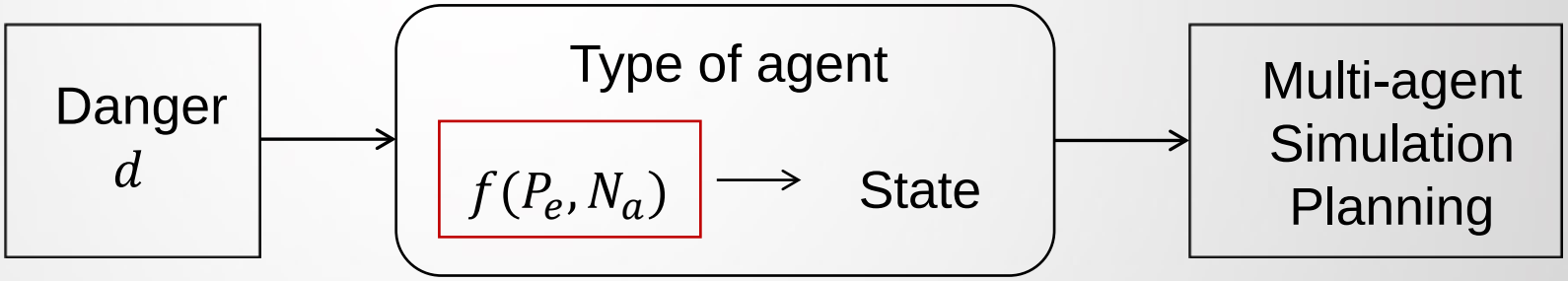
- Calculate mean from user study
- Mapping mean to parameter value



4. Mapping

Escape Algorithm

- We add escape algorithm for escape scene.



P_e: *Escape Probability*
N_a: *Num of Affected Neighbor*

Contents

5. Result

Escape scene

- Private S.C. agents start move first then default agents follow them (private: purple, white: default)

5. Result

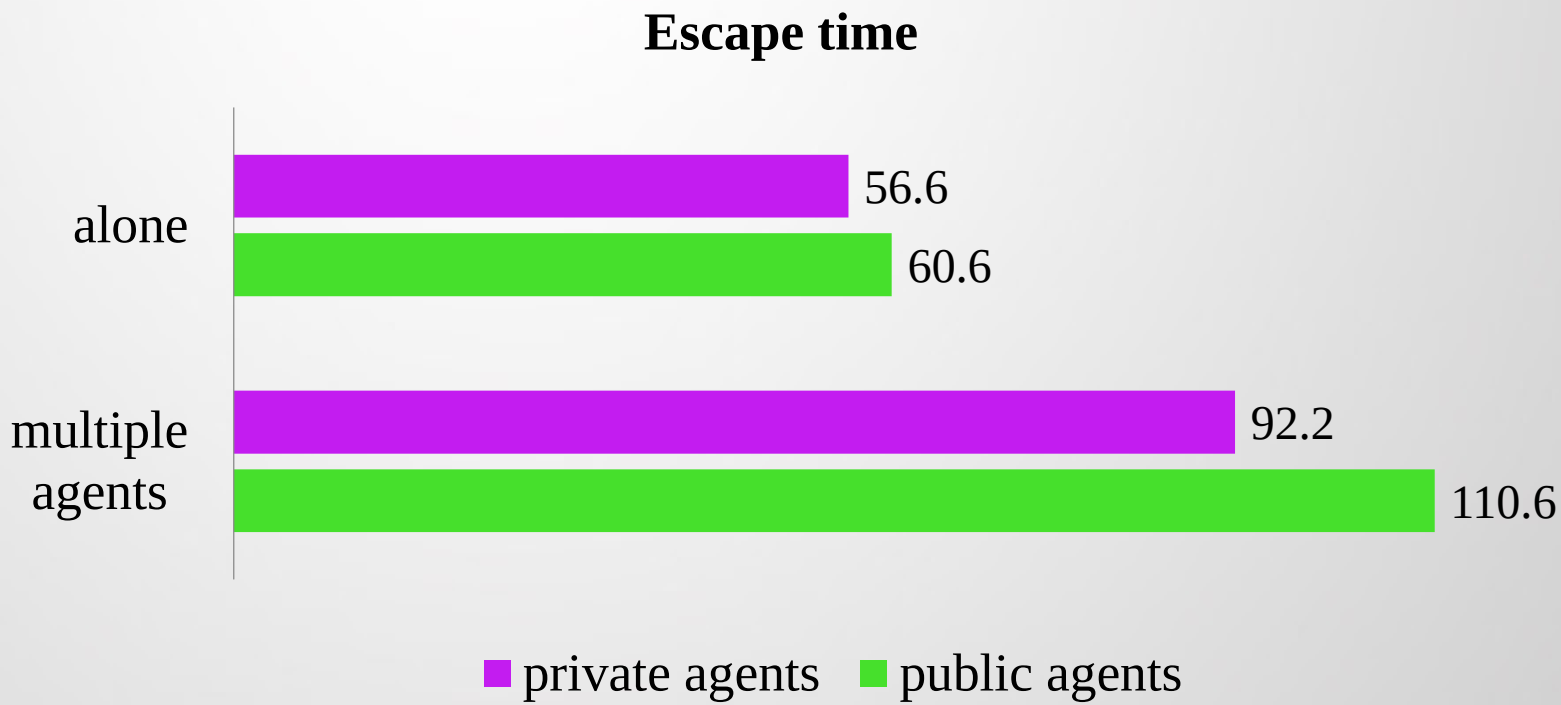
Escape scene

- Default agents start move first then public S.C. agents follow them (public: green, white: default)

5. Result

Escape time for agent type

- Escape time is depends on existence of other agents.



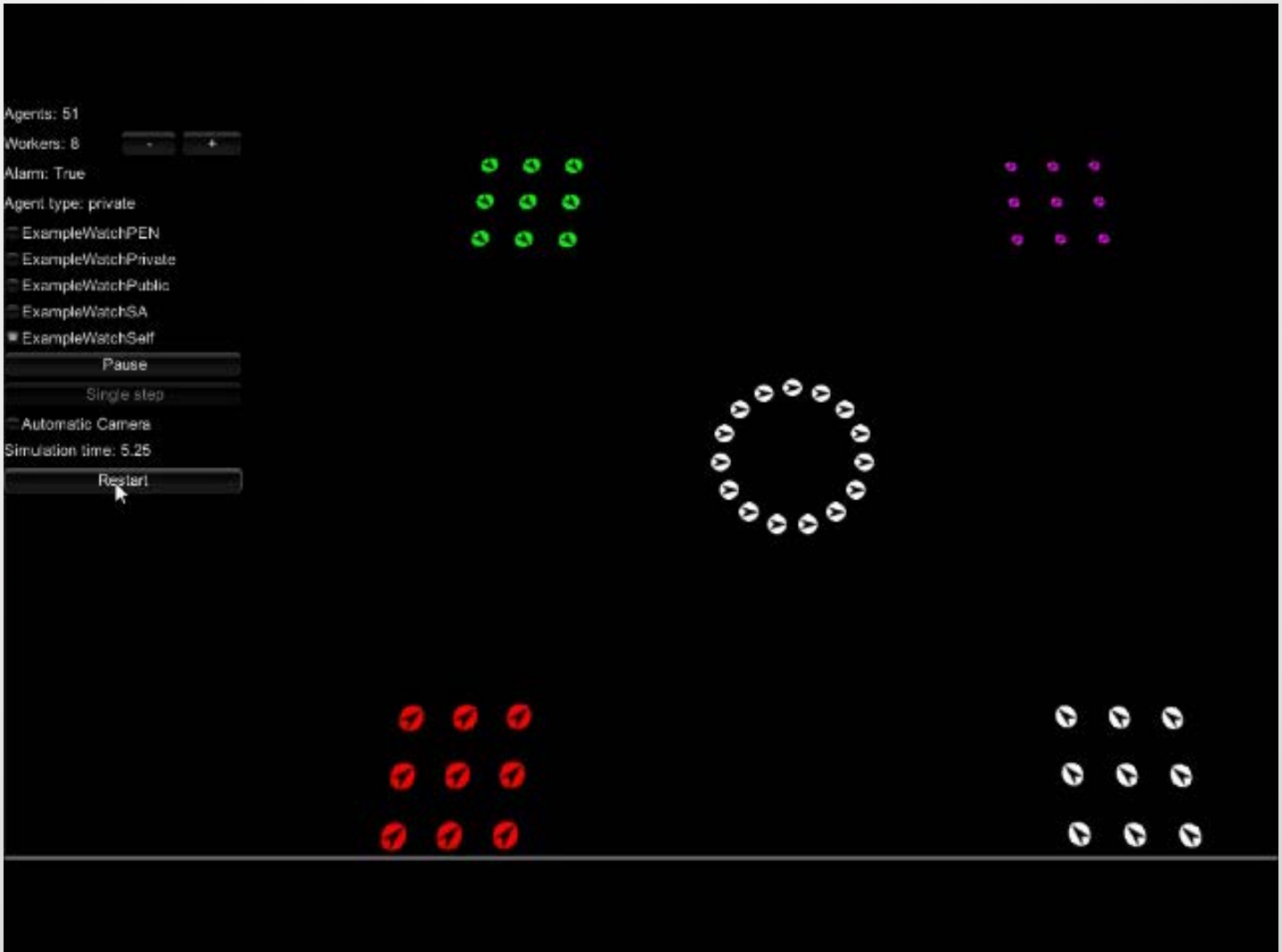
5. Result

Bystander scene

- Compare ours and PEN modeling *[Stephen at el., SCA 2011]*
  - Psychoticism, Extraversion, Neuroticism

5. Result

Bystander scene (Ours)



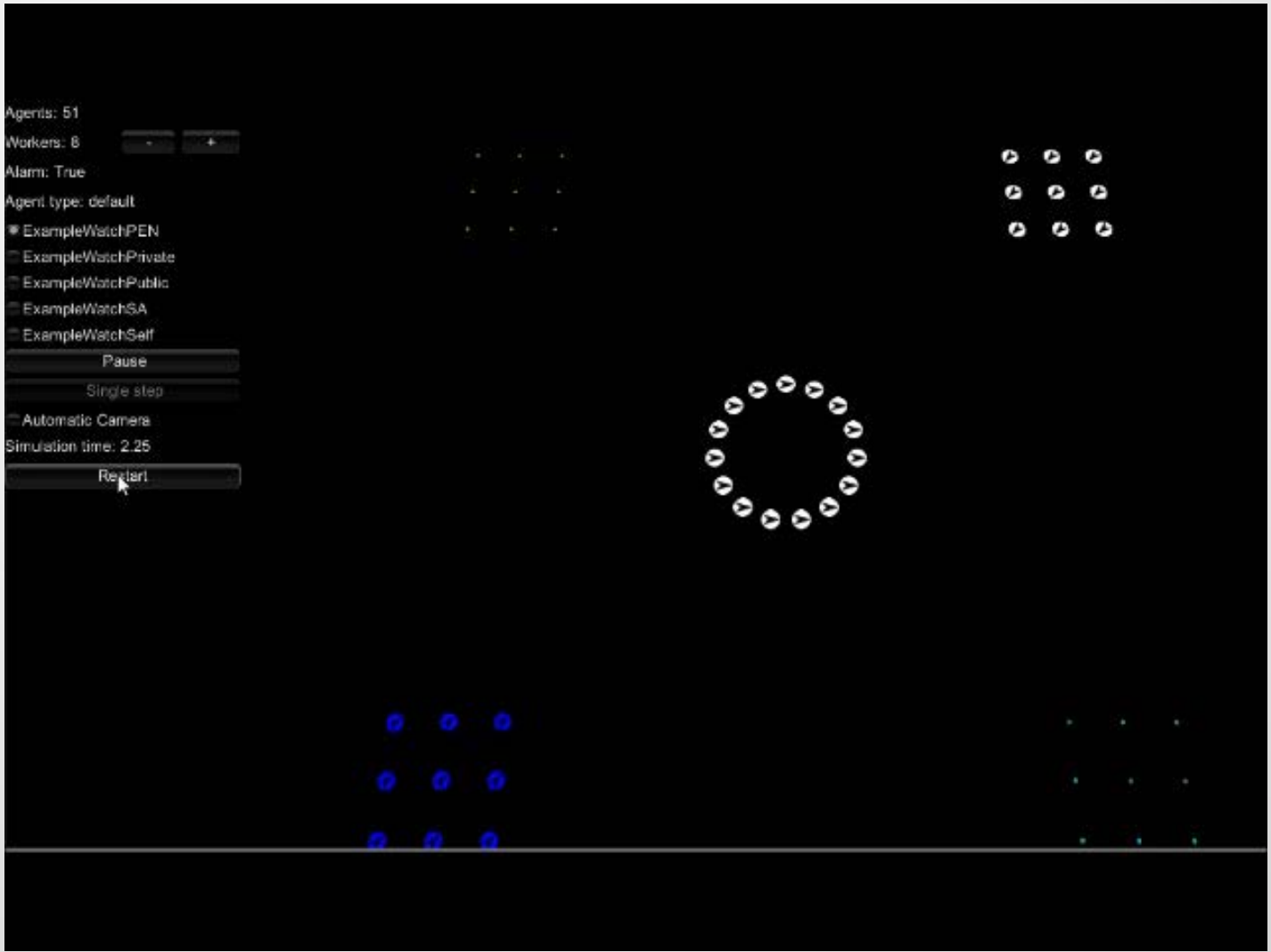
public: green

private: purple

S.A.: red

5. Result

Bystander scene (PEN model)



P: yellow

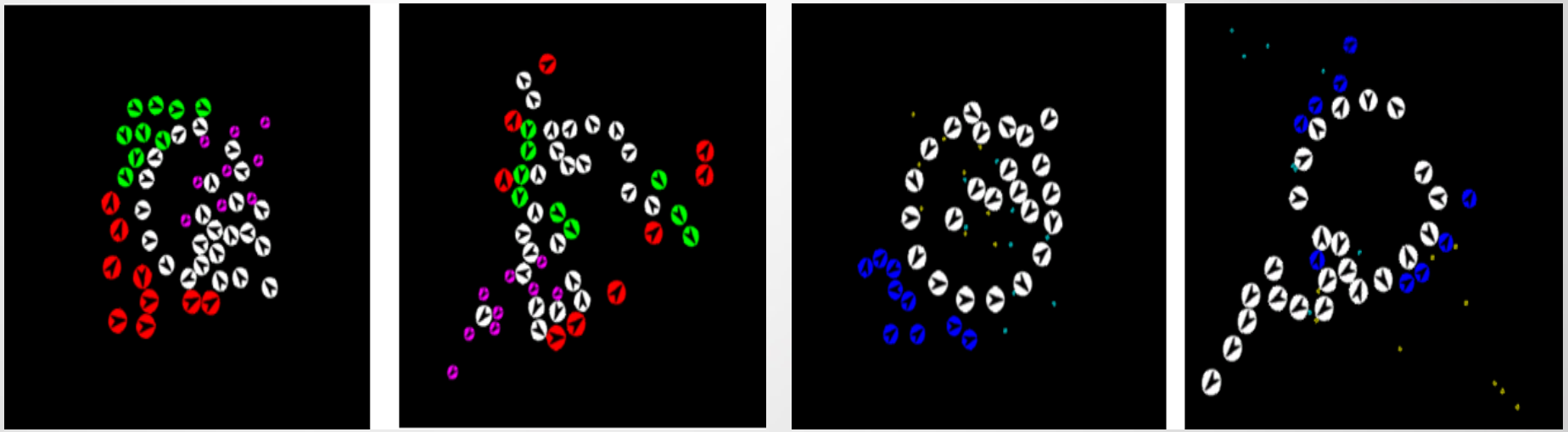
E: sky blue

N: blue

5. Result

Bystander scene

- In our model, radius of agents are similar with default
- Some radius of agents are too small in PEN model



Ours

PEN model

Contents

6. Conclusion

Contribution

- Simulate agents following Self-consciousness theory
- Behavior of agents depends on existence of other agents nearby

6. Conclusion

Limitation & Future work

- Hard to divide people into three categories
- Considered most representative element in current work

- More detailed simulations that can consider agent with all three elements

Thank you

Sources

Images

- World war z: https://encrypted-tbn1.gstatic.com/images?q=tbn:ANd9GcSab3wsFzFsjFyiQ9gvG4_bMwebirbLC3eZKtnvnMq9CDM9-u8X
- Agent based modeling: http://www.anylogic.com/upload/medialibrary/b34/b348de15a0a5c94f9c35b60b5040256f.jpg
- Eye: http://aldinsjourneytolife.files.wordpress.com/2012/07/self_conscious-1.jpg
- 심슨: http://trades4alpha.com/wp-content/uploads/2014/08/angry-mob-simps-300x255.jpeg
- Modeling: http://vision.eecs.ucf.edu/ICCVWorkshop/images/im3.jpg
- Escape: https://www.openabm.org/files/books/1928/6k-RoomExit4.png

Object retrieval and localization with spatially-constrained similarity measure and k-NN re-ranking [X. Shen et al., CVPR 2012]

Appendix

HiDAC

Object retrieval and localization with spatially-constrained similarity measure and k-NN re-ranking [X. Shen et al., CVPR 2012]

7. Future work

Mapping Funtion

Psychology Paper

Public and Private Self-consciousness: Assessment and Theory. (A Fenigstein et al., CCP 1975)

Mean, STD, CORR

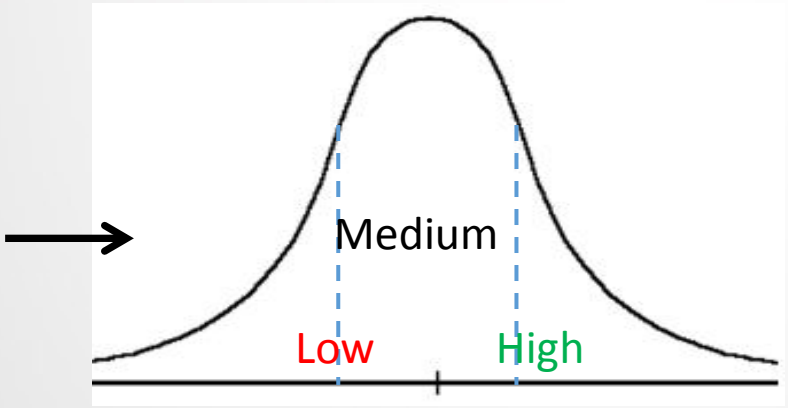
Real Data (using)

Private	Pubic	SA
55.80646	68.29474	49.07755
56.41527	58.61231	47.64184
64.30821	67.71022	56.14009
67.42495	63.89216	47.13814
65.06797	58.49045	49.7074
56.10205	63.73622	44.17011
63.25333	60.73348	53.22482
69.96705	64.23173	50.86451
63.74826	74.55629	57.04068
71.32569	71.08718	56.77651
60.46243	65.71347	59.43891
71.37884	59.03293	47.14616
72.03881	68.67361	52.15387
66.5757	65.64989	48.99865
55.32025	66.69268	53.38394

7. Future work

Mapping Funtion

Classification



(Private SC, Public SC, Social Anxiety)		
(H,H,H) : 8	(H,H,M) : 1	(H,H, L) : 3
(H,M,H) : 4	(H,M,M) : 2	(H,M, L) : 2
(H, L,H) : 1	(H, L,M) : 2	(H, L, L) : 2
(M,H,H) : 5	(M,H,M) : 2	(M,H, L) : 3
(M,M,H) : 8	(M,M,M) : 2	(M,M, L) : 6
(M, L,H) : 2	(M, L,M) : 2	(M, L, L) : 4
(L,H,H) : 2	(L,H,M) : 2	(L,H, L) : 0
(L,M,H) : 2	(L,M,M) : 3	(L,M, L) : 2
(L, L,H) : 1	(L, L,M) : 5	(L, L, L) : 3

7. Future work

Mapping Funtion

Mapping with RVO parameters

Level		Neighbor Distance	Max Neighbors	Radius	Prefer Speed	Time Horizon
Private SC	H	-30%	-30%	-40%	+30%	+30%
	M	default (15m)	default (10)	default (1m)	default (1.45m/s)	default (3)
	L	+30%	+30%	+40%	-30%	-30%
Public SC	H	+40%	+40%	-30%	0	-40%
	M	default	default	default	default	default
	L	-40%	-40%	+30%	0	+40%
Social Anxiety	H	+80%	-50%	+80%	0	+60%
	M	default	default	default	default	default
	L	-80%	+50%	-80%	0	-60%

Appendix

RVO library

- Reciprocal Velocity Obstacle