Collective Decision Making with Heterogeneous Agents

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Swarm Intelligence
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Solution

- Honeybees house hunting behavior + opinion dynamics
- Main idea from:
  - Valentini, G., Hamann, H., Dorig, M.: Self-organized collective decision making: The weighted voter model. In: Proceedings of the 2014 International Conference on Autonomous Agents and Multi-agent System. AAMAS'14, Richland, SC, International Foundation for Autonomous Agents and Multiagent Systems (2014)

Honeybees House-hunting Behavior

- Waggle dance
  - Upon finding a new *site* for nest, honeybee returns to the *nest* and waggle dance.
  - Waggle dance encodes the information like distance, quality, angle, etc.
  - Recruit nest mates to survey the site.
- Survey
  - Assess the quality of site

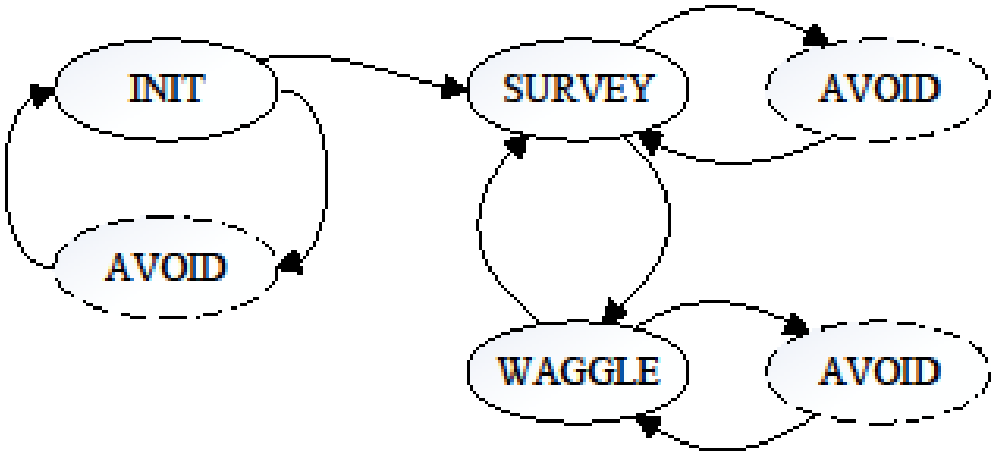
Opinion Dynamics

- Classic voter model
  - Communication with neighbors
  - Random agent adopts the opinion of a random neighbor on each time step.

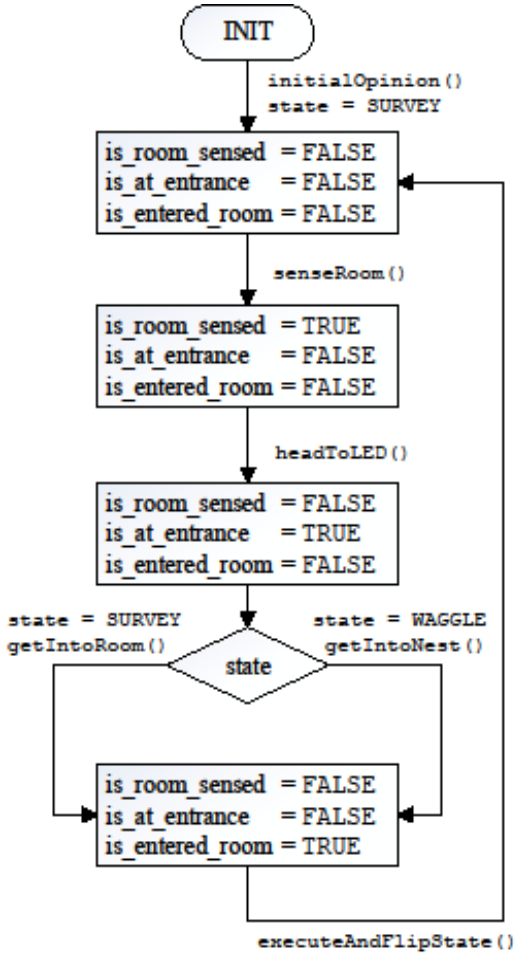
Hybrid Approach

- Classic voter model + house-hunting behavior of honeybees.
- Positive feedback:
  - Waggle dance duration is directly proportional to the quality of site.
  - Higher the quality $\rightarrow$ longer the waggle dance $\rightarrow$ higher the probability to influence neighbors to take the same decision.

State Machine



Flowchart & Algorithm




```
/* Flowchart to pseudocode */
1.  state = INIT;
2.  initialOpinion();
3.  state = SURVEY;
4.  if is_room_sensed then
5.     headToLED();
6.  else if is_at_entrance then
7.     if state == SURVEY then
8.        getIntoRoom();
9.     else
10.       getIntoNest();
11. else if is_entered_room then
12.    executeAndFlipState();
13. else
14.    senseRoom();
```

Metrics & Time

v_G – Evaluation of ground sensor

v_L – Evaluation of flight sensor

v_O – Evaluation of number of objects

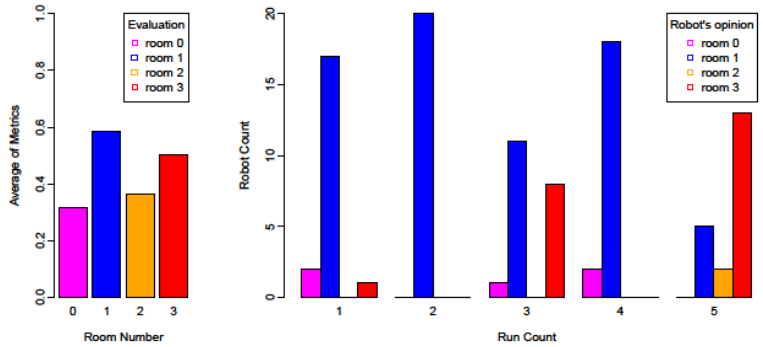
$$v = \begin{cases} (v_G + v_O)/2 & \text{if type G robot} \\ (v_L + v_O)/2 & \text{if type L robot} \end{cases}$$

- SURVEY
  - Uniform random number between 150 and 300.
- WAGGLE
  - Exponential value proportional to the average quality v.

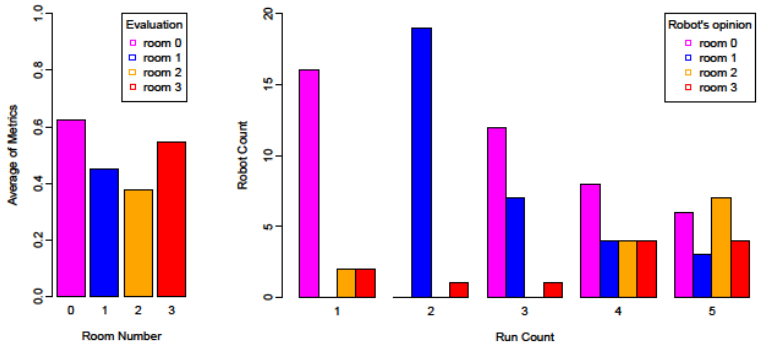
$$t = W\lambda(1 - e^{-\lambda v}) \text{ where } \lambda = -2 \text{ and } W = 40$$

Results (1)

$T_G = 10, T_L = 10$ Totaol: 20 robots

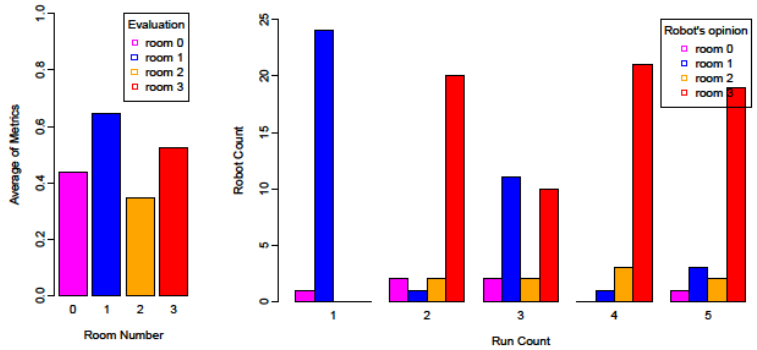


$T_G = 10, T_L = 10$ Totaol: 20 robots

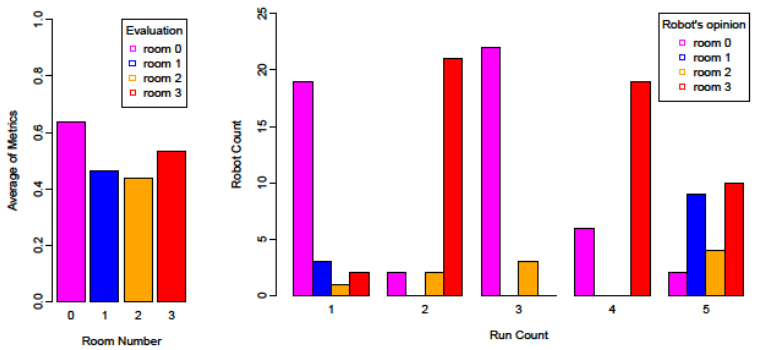


All results are for 5000 ticks

$T_G = 12, T_L = 13$ Totaol: 25 robots



$T_G = 13, T_L = 12$ Totaol: 25 robots



T_G – No. of type G robots

T_L – No. of type L robots

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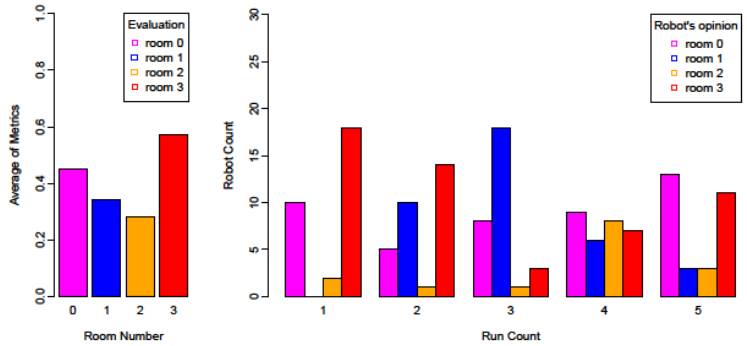
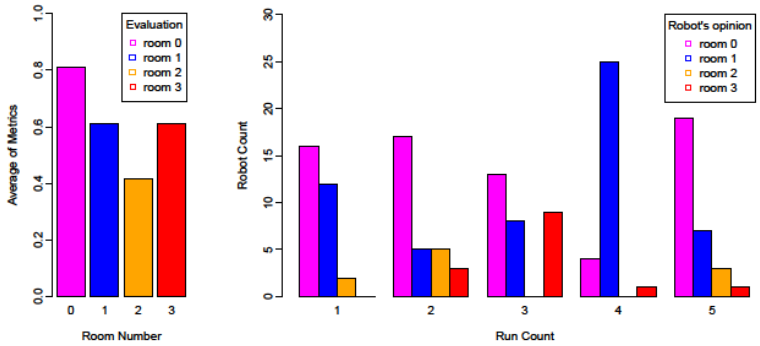
Results (2)

$T_G = 15, T_L = 15$ Totaol: 30 robots

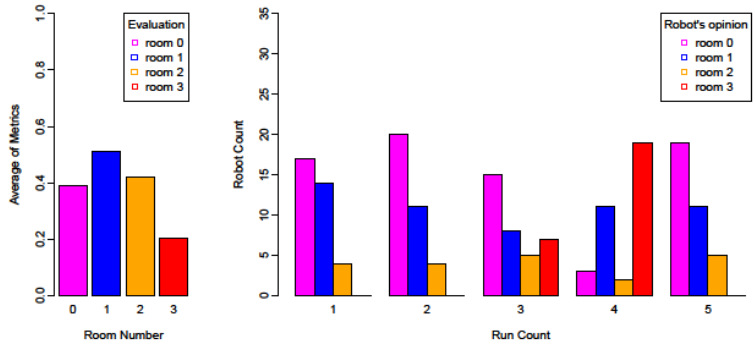


$T_G = 15, T_L = 15$ Totaol: 30 robots

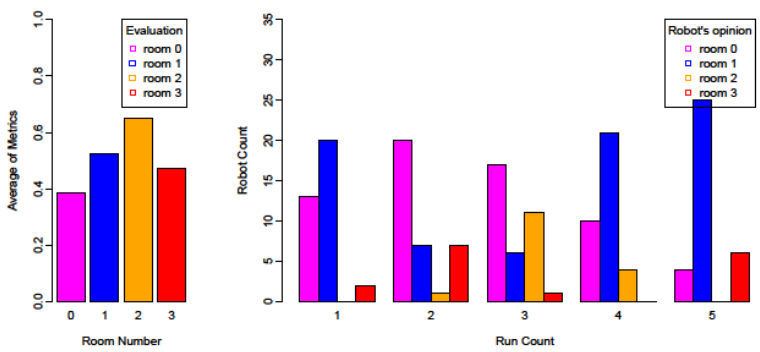


All results are for 5000 ticks

$T_G = 17, T_L = 18$ Totaol: 35 robots



$T_G = 18, T_L = 17$ Totaol: 35 robots



T_G – No. of type G robots

T_L – No. of type L robots

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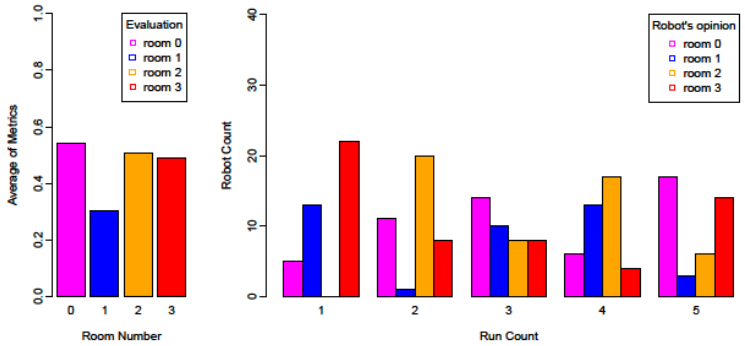
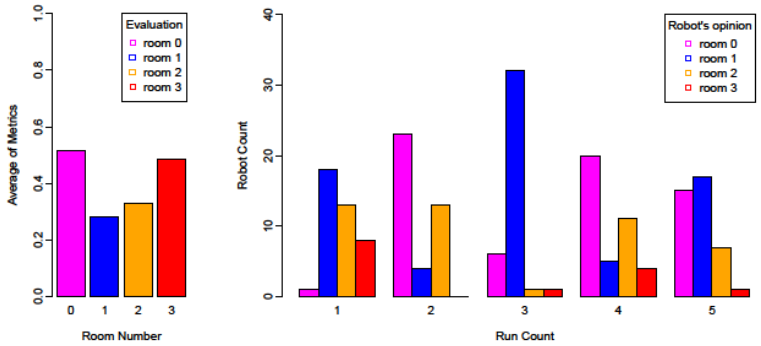
Results (3)

$T_G = 20, T_L = 20$ Totaol: 40 robots



All results are for 5000 ticks

$T_G = 20, T_L = 20$ Totaol: 40 robots



T_G – No. of type G robots

T_L – No. of type L robots

- If T_G is higher than T_L then robots deviates towards the room where v_G value is high.

Thank you