Requirements to Agent based Disaster Simulations from Local Government Usages

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Introduction

- approaches to use agent technology for simulating social phenomena:
  - to expand possibilities of MAS,
  - to support modeling one social activity,
  - to use simulation results in daily life
- Disaster and rescue simulation as social simulations
  - interactions between human activities and disasters!
  - MAS is key technologies.
RoboCup Rescue Simulation System

da comprehensive rescue and disaster simulation system.

- competitions and Ohta, Farinelli, Schurr etc.
- tasks or fields (different in structure and size).
- domain-specific features.
- simulation results to practical use (image)

Physical disasters
1st
Collapse of Buildings & roads
2nd
Traffic jams, Fires

Burning, extinguished

Rescue simulations

For what
- training on computers
- visualization of hazards
- their own roles at neighborhoods

Roads, rivers, refugees, hospitals, ...
Agent based disaster simulation

- Scientific and engineering fields

  
  guess → compute consequence → compare experiment

- used as experiments tools.
  ♡ time, money & repeat.

- Disaster and rescue fields:
  
  no experiments physically on real scale
  ♡ and human as one factor.

  Yes, ♡
  
  Agent-based simulation is promising!
  It makes possible to simulate disasters and rescue.
usage as disaster management system I

Form 2003 to 2005

- 5 earthquakes with more 1,000 deaths. (tsunami Northern Sumatra)
- Hurricane Katrina at 2005 September.

<table>
<thead>
<tr>
<th>disasters</th>
<th>components</th>
<th>usage</th>
<th>time used</th>
</tr>
</thead>
<tbody>
<tr>
<td>natural disasters</td>
<td>simulators</td>
<td>data</td>
<td>items evaluated</td>
</tr>
<tr>
<td>natural</td>
<td>earthquake</td>
<td>fire</td>
<td>human lives</td>
</tr>
<tr>
<td></td>
<td>tsunami</td>
<td>smoke</td>
<td>facilities</td>
</tr>
<tr>
<td></td>
<td>typhoon</td>
<td>collapse</td>
<td>damages</td>
</tr>
<tr>
<td></td>
<td>flood</td>
<td>*building, mudslide</td>
<td>* public property</td>
</tr>
<tr>
<td>man-made terror</td>
<td>human activity</td>
<td>*traffics</td>
<td>life lines</td>
</tr>
<tr>
<td></td>
<td></td>
<td>*evacuation</td>
<td></td>
</tr>
</tbody>
</table>

*smoke
*building, mudslide
*public property
*private property
*flooding
usage as disaster management system II

from MAS to disaster management system:

(a) single agent

(b) multi agents

(c) disaster rescue simulation

(d) disaster management system

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evaluation of disaster simulation results II

\[\text{guess} \rightarrow \text{compute consequence} \rightarrow \text{compare experiment}\]

(1) what targets of the simulations are,
(2) under what conditions the simulations are done,
(3) what computational models of simulations are,
(4) what kind of criteria assures simulation results?

\[\text{plan} \rightarrow \]

\[\text{compute damages} \rightarrow \text{compare past data} \]
\[\underbrace{\text{as a estimation of models}}\]
\[\rightarrow \text{compare plans} \]
\[\underbrace{\text{usage as disaster management tool}}\]
evaluation of disaster simulation results II

- computational model
- human behavior model
- evaluation standard

\[ S = \{G, Ag, \Sigma, E, Ac, C\} \]

<table>
<thead>
<tr>
<th></th>
<th>quantitative factor</th>
<th>qualitative factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Ag)</td>
<td>number of agents</td>
<td>social hierarchy (fire man, fire office)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>agents’ character (friendly, selfish, ..)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>act with (without) prior knowledge</td>
</tr>
<tr>
<td>(\Sigma)</td>
<td>disaster (fire, collapse simulation,..)</td>
<td>models and precision of each disaster</td>
</tr>
<tr>
<td></td>
<td>life line (traffic, communication, ..)</td>
<td></td>
</tr>
<tr>
<td>(E)</td>
<td>area size of target</td>
<td>resolution of GIS, 2, 3 dimensional</td>
</tr>
<tr>
<td></td>
<td></td>
<td>underground mall</td>
</tr>
<tr>
<td>(Ac)</td>
<td>interaction model with environments, interaction model among agents</td>
<td>commands, protocol communication band</td>
</tr>
<tr>
<td>(C)</td>
<td>sensing power</td>
<td>partial view, hearing of voice with errors (imperfect world)</td>
</tr>
</tbody>
</table>
Discussions based RoboCup Rescue Formul

\[ V = (P + \frac{H}{Hint}) \times \sqrt{\frac{B}{B_{\text{max}}}} \]

Fig. Scores at RoboCup 2004

Table. Change performances for sensing abilities

<table>
<thead>
<tr>
<th>sensing condition</th>
<th>normal(s)</th>
<th>( r_1 )</th>
<th>( r_2 )</th>
<th>( r_3 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>team X</td>
<td>78.92</td>
<td>78.92</td>
<td>79.92</td>
<td>78.91</td>
</tr>
<tr>
<td>team Y</td>
<td>97.69</td>
<td>35.41</td>
<td>83.49</td>
<td>90.87</td>
</tr>
<tr>
<td>team Z</td>
<td>88.24</td>
<td>83.30</td>
<td>51.45</td>
<td>45.76</td>
</tr>
</tbody>
</table>

discussion 1:

1. robust or efficient?

2. What standard of evaluate agents’ performance and simulation results?
As Task Allocation Problems

discussion 2:

fires:
- enough fire engines to extinguish fires.
- how fast and efficiently they can extinguish them.

disasters: fires break out simultaneously.
- inadequate powers to extinguish all fires.
- changes their policy of rescue.

1. Is it calculable to evaluate agent’s ability under the same standards?

2. From decision supporting view points, change parameters and compare the rescue activities. How simulation results will be verified?
Simulation results Comparison

discussion 3:
1. Which one does local government use?
2. What are sufficient conditions to use simulations results as their planning?
discussion 4: different simulation results:

1. to V.0.46 fire simulation based on Kobe-Awaji disaster. from V0.47 a new one based physical model makes with preemptive cooling.

2. simulations with different scale:
Comparison: Nagoya fire Bureau’s data

discussion 5:

1. Area for simulations?
2. Rescue agents have knowledge beforehand. How well do they know?

<table>
<thead>
<tr>
<th>ward</th>
<th>No. ignitions</th>
<th>no fire brigade</th>
<th>fire brigade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nichi</td>
<td>30 (night)</td>
<td>8.53%</td>
<td>8.08%</td>
</tr>
<tr>
<td></td>
<td>58 (day)</td>
<td>13.40%</td>
<td>12.96%</td>
</tr>
<tr>
<td>Nakamura</td>
<td>22 (night)</td>
<td>8.90%</td>
<td>8.45%</td>
</tr>
<tr>
<td></td>
<td>45 (day)</td>
<td>15.64%</td>
<td>15.23%</td>
</tr>
<tr>
<td>correlation with data*</td>
<td>0.89</td>
<td>0.92</td>
<td></td>
</tr>
<tr>
<td>Clipped area</td>
<td></td>
<td>7.20%</td>
<td>7.14%</td>
</tr>
</tbody>
</table>

*: from same report used in column A (Table.4)
Summary

- MAS will
  - more agents and wider area simulations.
  - provide experiments that would otherwise be impossible.

- results tested with real data, also be analyzed systematically.

A universal method to evaluate agents will be one of the key issue, With RoboCup Rescue simulation data,

- discuss some requirements when disaster management will have in applying practical usages.

- future research topics in developing disaster estimation to a practical one.