



Multi-Agent Simulation of Disaster Response

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AAMAS'06, ATDM Workshop



Motivation: Testing IT in emergency response

- Efficacy of emergency response plays a key role in the consequences of the disaster
- Information technology (IT) can improve efficacy by delivering the right information to the right people at the right time
- Need for testing IT in the context of emergency response
 - Drills: realistic settings but expensive
 - Simulation: cheaper, but lacks realism and validation



DrillSim: A testbed

- DrillSim *simulates* a crisis response activity (e.g, evacuation)
- DrillSim allows testing IT solutions in the context of the *simulated* response activity
 - Plug-and-Play capabilities
- Translates IT metrics to response metrics
 - E.g., Bandwidth usage, time, accuracy to casualties, response time, risks taken



DrillSim: An augmented reality simulator

- DrillSim can simulate a crisis response activity
 - DrillSim can also be synchronized with an on-going drill:
 - Simulated drill augments an on-going drill adding
 - Simulated people
 - Simulated communications infrastructure
 - Simulated sensing infrastructure
- *Lowers cost of a real drill, adds flexibility*



DrillSim: An augmented reality simulator

- DrillSim can simulate a crisis response activity
- DrillSim can also be synchronized with an on-going drill:
 - Simulated drill augments an on-going drill adding
 - Simulated people
 - Simulated communications infrastructure
 - Simulated sensing infrastructure
 - ***Lowers cost of a real drill, adds flexibility***
 - On-going drill augments simulated drill
 - Real people
 - Real communications infrastructure
 - Real sensing infrastructure
 - ***Adds realism, allows for calibration of the simulated entities***

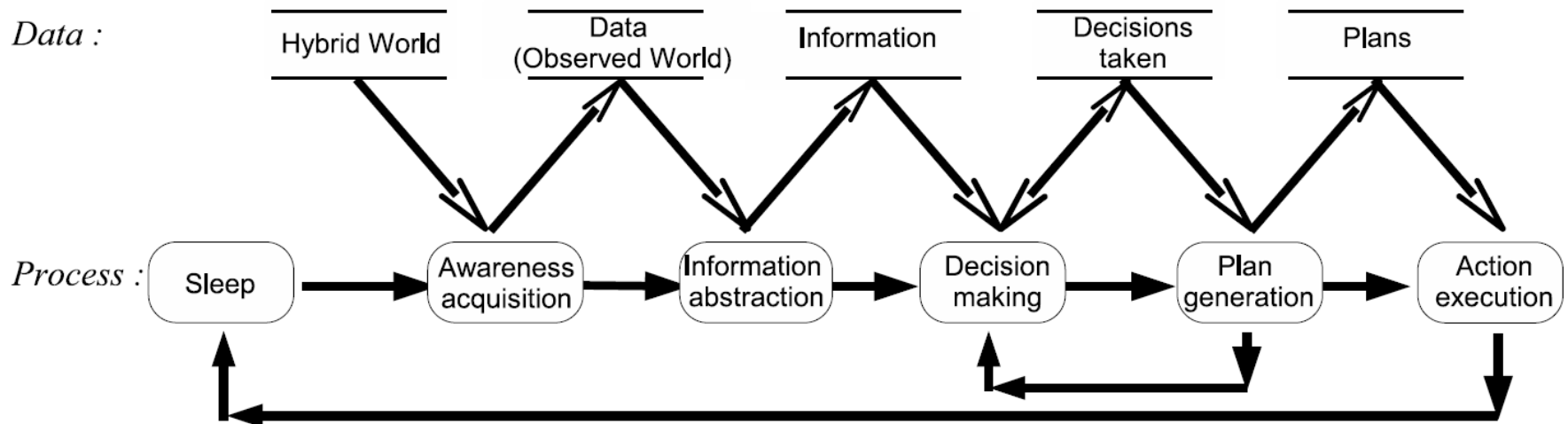


DrillSim: A Multi-Agent Simulator

- **One agent** simulates **one person**
- Multiple **roles**:
 - Evacuee
 - Floor warden
 - Building coordinator
 - Zone captain
 - Etc.
- Individual **profiles** (physical and cognitive abilities)
- Relationship between agents -> social networks.
- Agents involved in information flow
 - Collect information via their own *sensors* (e.g., eyes), or the devices they carry (e.g., PDA)
 - Analyze information (i.e., assimilate information, make decisions)
 - Share and disseminate information via their own communication *devices* (e.g., speech) or the devices they carry (e.g., PDA)

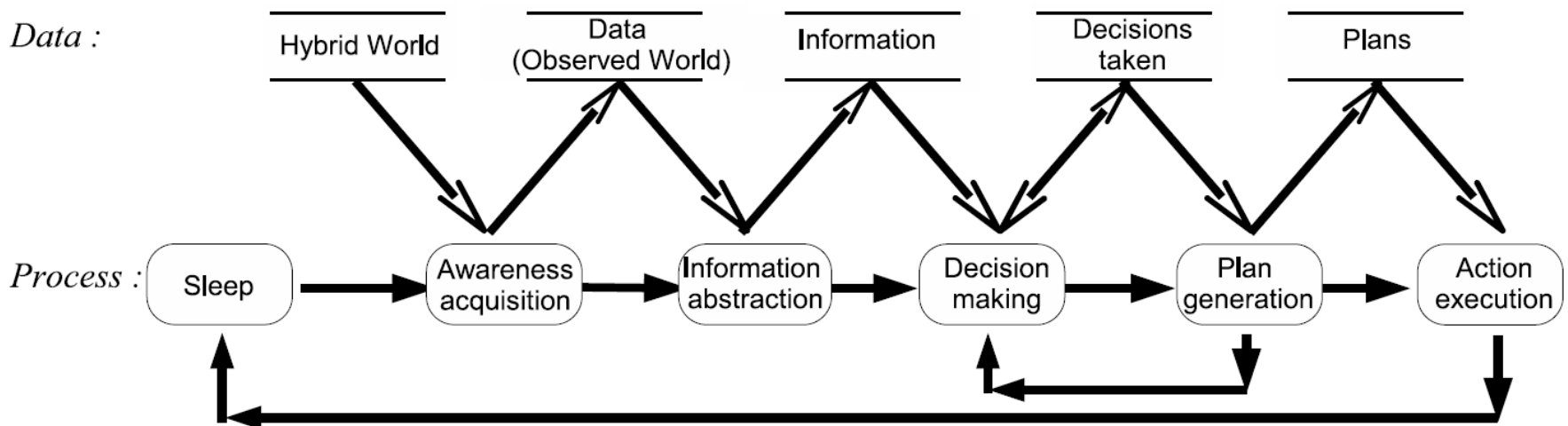
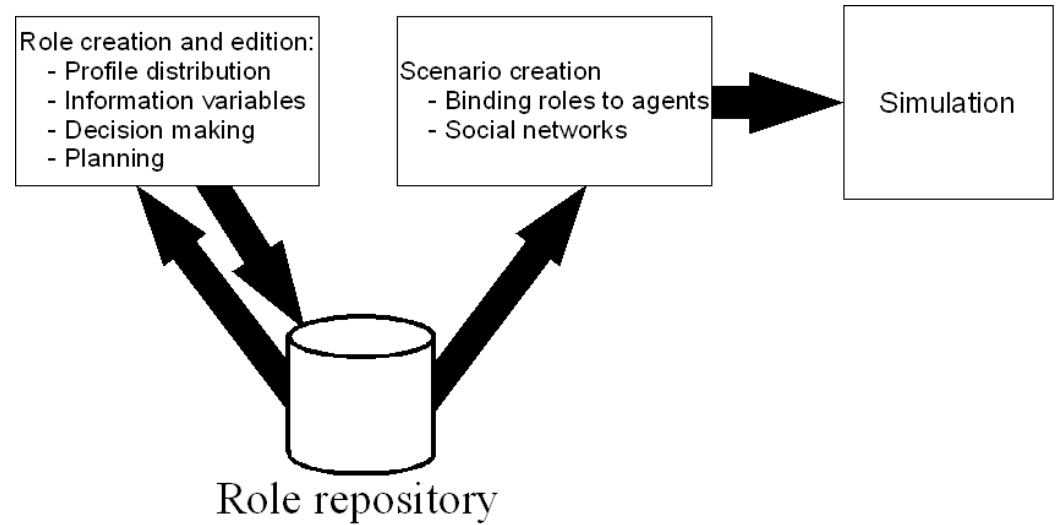
DrillSim Agent Model

- Information processing
- Clear interfaces between stages



Agent Role Editing

- A scenario is created by binding roles and profiles to agents
- An agent roles is an instantiation of each information processing step

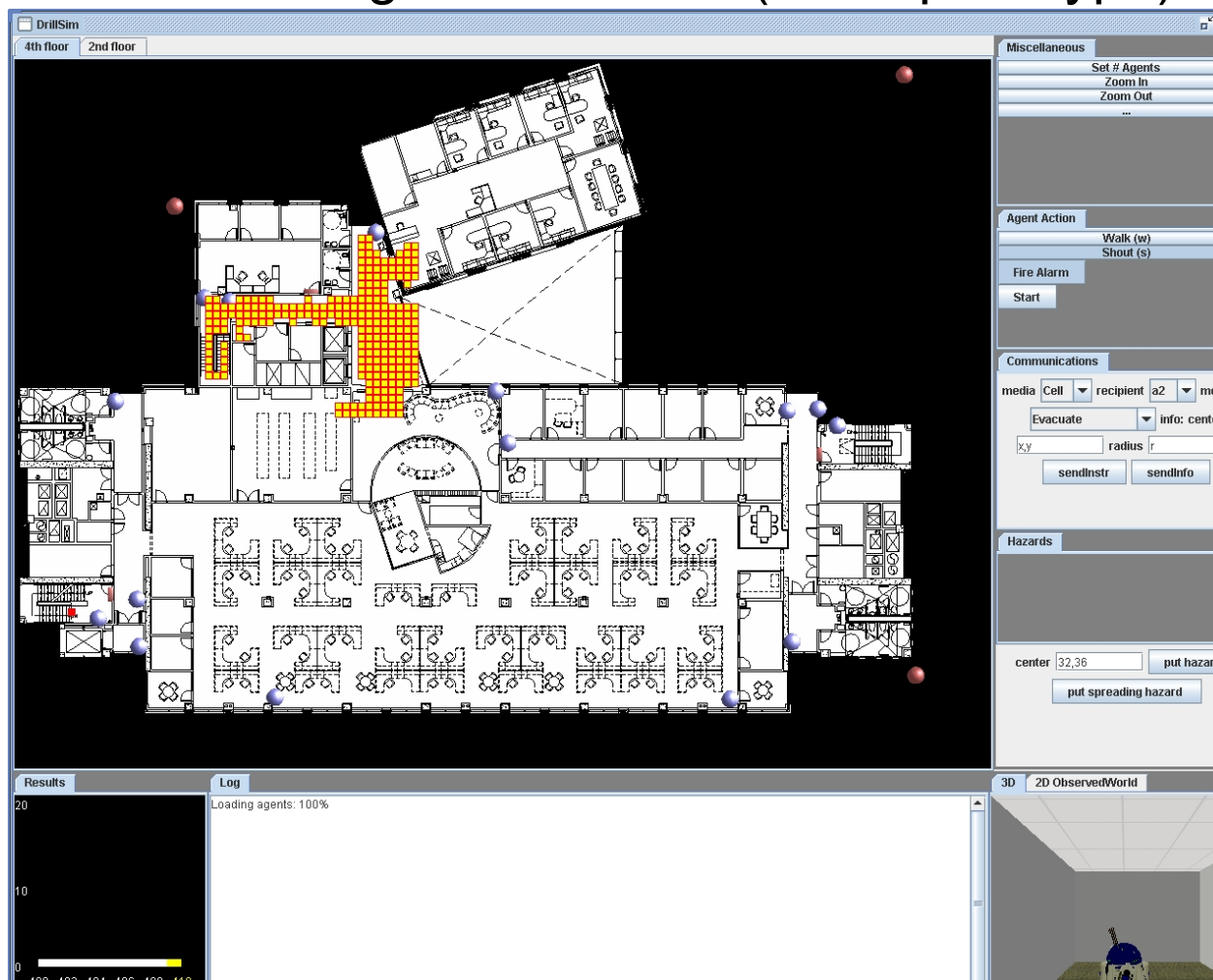




Come see the demo:
Thursday May 11th, 12:05 - 13:25

Synthetic Humans in Emergency Response Drills

demonstrating DrillSim v0.2 (basic prototype)





<http://www.ics.uci.edu/~projects/drillsim>

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AAMAS'06 : ATDM workshop, Monday May 8th, 2006, Hakodate,
Hokkaido, Japan



EXTRA SLIDES

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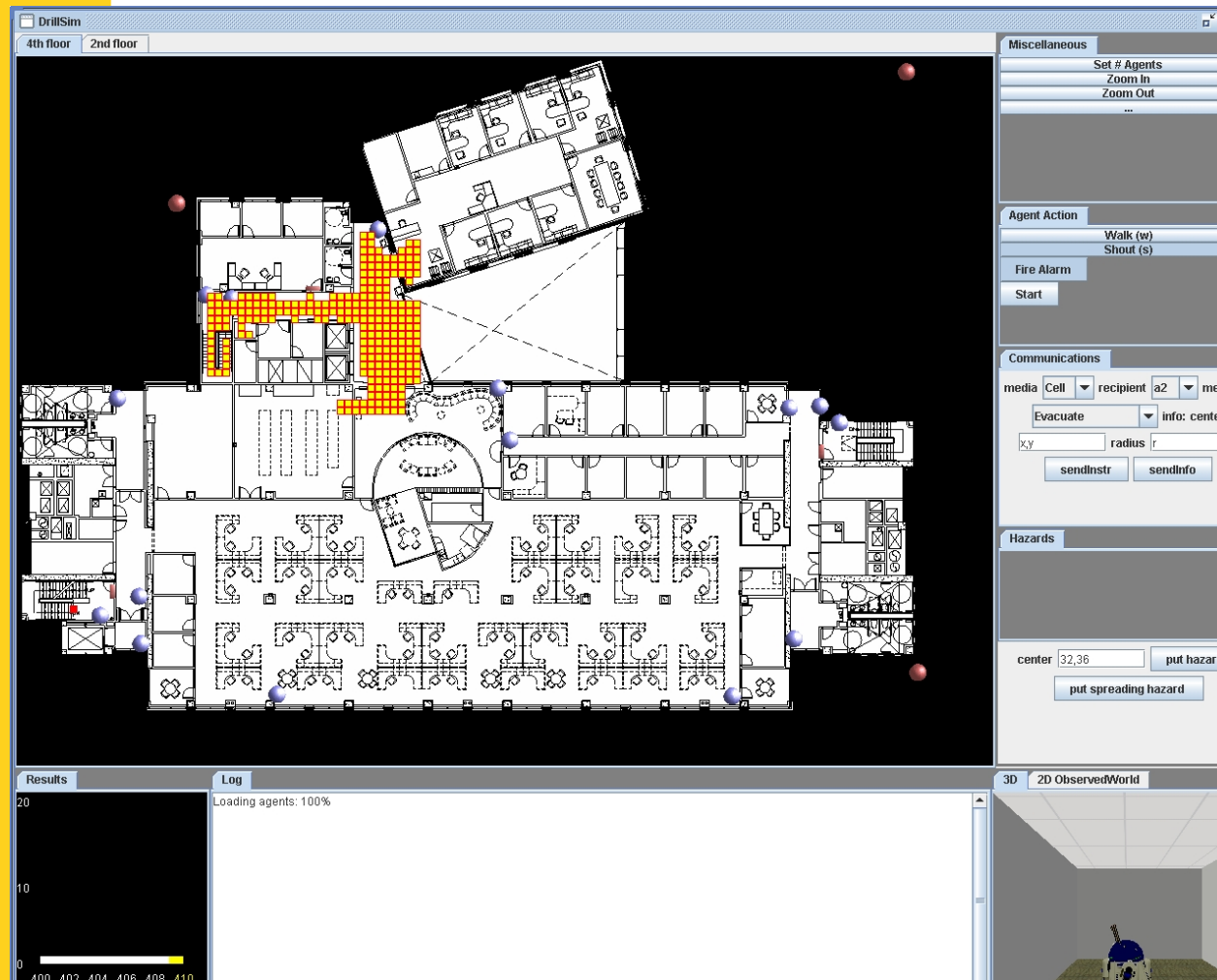
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DrillSim v0.2 – basic prototype

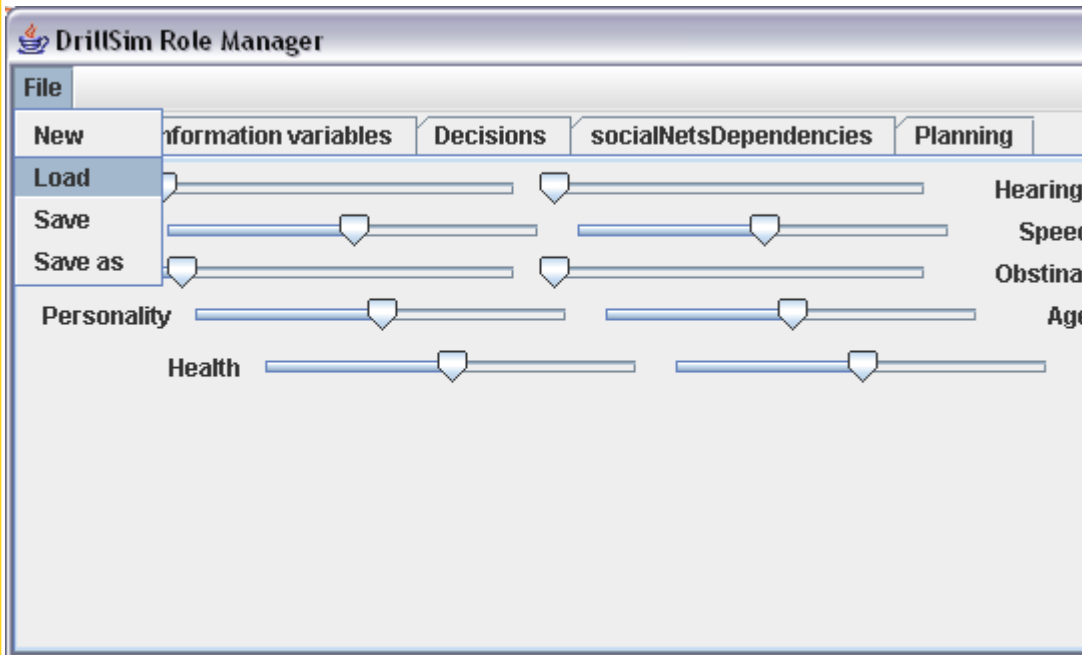


- Response activity: evacuation
- 4th floor Cal(IT)2
- Grid representation
- A* algorithm + obstacle avoidance
- Stochastic decision making based on ANN
- Evacuee and floor-warden roles
- 2D/3D interface
- Human can control an agent
- Human can communicate with agents
- Simplified crisis model (spreading fire)
- Response metric: number of people in building vs time



Current status

- Achieved:
 - Role management



```

<?xml version="1.0" encoding="UTF-8"?>
<Role id="OfficeBuildingEvacuee">
  <profile>
    <visual>
      <mean>5.0</mean>
      <variance>0.5</variance>
    </visual>
    <hearing>
      [...]
    </profile>

    <informationVariables>
      <var id="ROOM_FULL"></var>
      <var id="KNOW_ABOUT_HAZARD"></var>
      [...]
    </informationVariables>

    <decisionMaking>
      <decision id="KNOW_ABOUT_HAZARD">
        <NN_weights>
          <w dst="EXIT">1.0</w>
        </NN_weights>
      </decision>
      <decision id="TOLD2EVAC">
        [...]
      </decision>
    </decisionMaking>

    <planners>
      <var id="evacuate"></var>
      <var id="exitFloor"></var>
      <var id="Default"></var>
    </planners>

    <socialNetsDependencies>
      <var id="trust"></var>
      <var id="waitFor"></var>
  </Role>

```



DrillSim v2.0 : where we are going

- Campus-wide evacuation
- Plug-and-play architecture: integration with MetaSim
- Scalable architecture ($O(100,000)$ agents)
- Integration with real world and real activities
- Realistic models for crisis, agent behavior, and initial scenario generator.
- Calibration of agent models



DrillSim: a *plug-and-play* system

- Plug models that drive simulation such as
 - human behavior,
 - spatio-temporal models (e.g., geography, class schedules)
 - crisis models,
 - response activity,
 - response plans.
- Plug IT solutions.
 - Response activity projected as information flow
 - Information is
 - Collected
 - Analyzed
 - Shared
 - Disseminated
 - IT solutions can be plugged at any of these points