Experience-based Agent Communities in support of Smart Environment Hypermedia MAS

Goal-driven interactions in Smart Environments

Alexandru Sorici, Andrei Olaru

National University of Science and Technology POLITEHNICA Bucharest

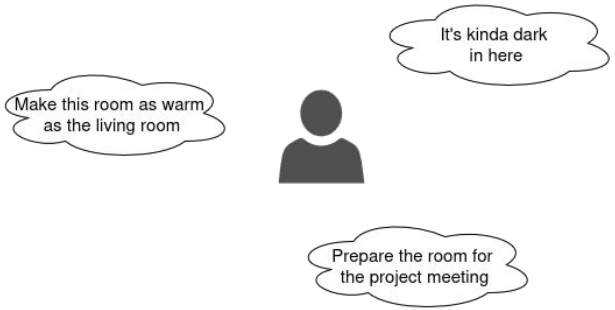


Agent Toolkits @ EUMAS 2025

AI-MAS Group
"AIM AS high as you can"

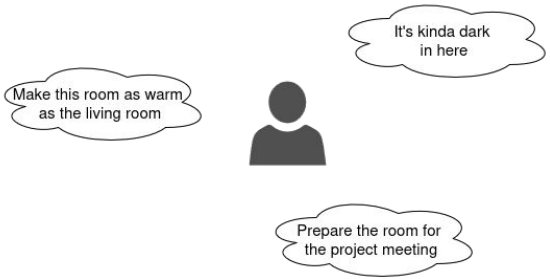
Challenges in Smart Environments

User-Environment interactions **should be** driven by goals



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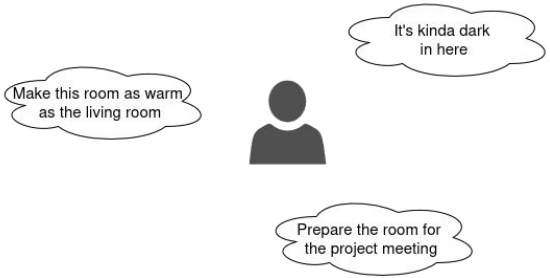


Goals can be **under-specified, e.g.**

- What can make the room brighter?
- Which project? How many people will attend?
- How warm is the living room? What makes it warmer?

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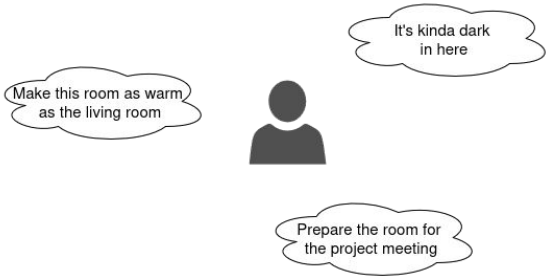
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Smart Environments are **heterogeneous in capabilities** and **dynamic in availability and context of use**



Need: systematic **support** *to understand* **human intentions,** *use* **environment affordances**, and *adapt* to **context of use.**

Modeling Smart Environments: a Hypermedia MAS view

- Environment resources modeled as **Hypermedia Artifacts**[1], using a Thing Description representation
- Artifact affordance **signifiers** as record units of ***experience of use***
- Example artifacts: light and temperature sensors, smart lights, blinds, people count sensor, …

```
<http://localhost:8080/workspaces/lab308/artifacts/light308/#artifact>
    a td:Thing,hmas:Artifact, ex:HueLamp ;
    td:title "Hue Lamp with Context-Based Authorization" ;

    td:hasActionAffordance [
        a td:ActionAffordance, ex:ToggleCommand ;
        td:name "toggle" ;
        td:hasForm [
            htv:methodName "POST" ;
            hctl:hasTarget <http://localhost:8080/workspaces/lab308/artifacts/light308/toggle>;
            hctl:forContentType "application/json";
            hctl:hasOperationType td:invokeAction;
        ] ;
    ] ;

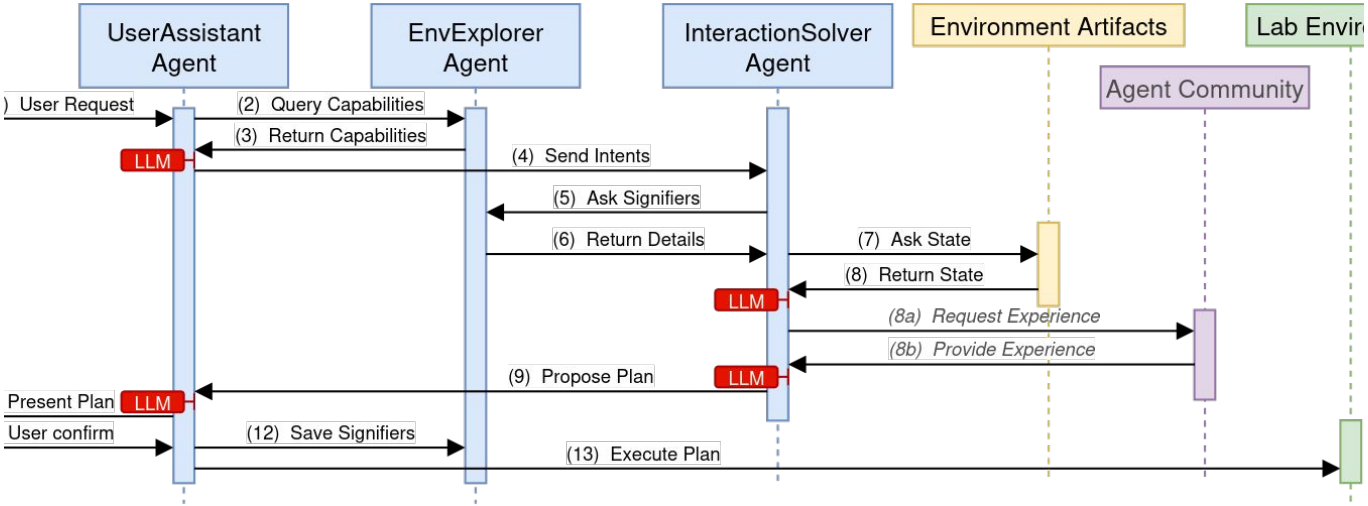
    td:hasActionAffordance [
        a td:ActionAffordance, ex:ColorCommand ;
        td:name "color" ;
        td:hasForm [
            htv:methodName "POST" ;
            hctl:hasTarget <http://localhost:8080/workspaces/lab308/artifacts/light308/color>;
            hctl:forContentType "application/json";
            hctl:hasOperationType td:invokeAction;
        ] ;
        td:hasInputSchema [
            a js:ObjectSchema ;
            js:properties [
                a js:StringSchema ;
                js:propertyName "color";
                js:oneOf ([js:const "red"]  [js:const "green"]  [js:const "blue"]);
            ] ;
            js:required "color" ;
        ] ;
    ] ;
```

[1] Ciortea, et al. Engineering world-wide multi-agent systems with hypermedia. EMAS 2018

AmI HMAS: agentic system for Smart Environments

- Specialized *agent roles:* **user request / feedback**, **environment monitoring**, **request interpretation / planning**
- LLM supported reasoning:
  - User request intent extraction
  - Solution planning
  - Plan summary for user evaluation
  - Environment state summary
- LLM planning uses *Signifier* representation as ***structured language*** to leverage ***affordance invocation*** and ***usage context***
- **Advantages:** *modularity, incremental experience gain, user-in-the-loop*

AmI HMAS: Combining *individual* + *community* experience



- **InteractionSolver agents** leverage **their own experience + community experience** of *similarly instrumented environments*

Communities: why? How do they form?

- Enable sharing of *experience-of-use* across *similarly instrumented* environments
  - Smart envs often have ***comparable devices*** and ***similar spatial layout***
  - … but ***different users*** with ***different preferences*** or ***different usage patterns***

- Dynamic RAG for LLM context:
  - Agents in a community **decide what to share:** single Signifier, abstract plan, instantiated plan

- Semi-automatic community formation:
  - Driven by **a developer** based on pre-existing environment setup
  - Driven by ***agents:*** using reasoning on set intersections of signified affordances and environment properties (e.g. layout, energy consumption, type of use)