University of Essex

Intelligent Association in Agent-based Ubiquitous Computing Environments

The IIEG Work

- **Primary Research Focus** - the creation of intelligent (learning) mechanisms that can be embedded into networked devices making up everyday living environments (targeting so called Ambient Intelligence, Pervasive and Ubiquitous Computing)
- **Secondary Research Focus** – Network Infrastructures, HMI, novel sensors / effectors
- **Projects**
  - eGadgets
  - careAgents
  - Social
  - MAN project
- **Test Beds**
  - iDorm
  - “Tomorrow’s World” Set
  - pDorm/mDorm
  - iFlat

Intelligent Ubiquitous Environments

The iDorm

Appliances
(Intelligent Embedded-Agents)

- Multimedia PC
- Desk lamp
- Bed lamp
- Room Heater
- Room Cooler
- Window Blind
- Active lock
- Ceiling lights
- Mobile (Servant-) Robot
- Telephone
- TV
- DVD
- CD Player
- Desk
- Chair
- Bed
- Mood Cube

Active/Passive Agents

- Actuators' state
- Occupancy
- Location
- Window state
- Indoor light level
- Outdoor light level
- Indoor humidity
- Time

Intelligent Ubiquitous Environments

Other existing environments

- iHOME
- MIT's Intelligent Room
- Microsoft Smart House
- Cisco's Internet House

-> most of the approaches focus on general-control mechanisms on the system-level

-> number of agents is limited and known to the designer of the MAS

-> the addition or disconnection of agents cannot be done dynamically

-> future trends show that agents might be self-identifying and support self-configuration

How can a system deal with the configuration management needs of an extensively "agentized" environments?

Intelligent Associations

What are Associations?

- Link between two or more agents/devices

How to establish associations?

- Manual
- Automatic
- Intelligent

Type of associations?

- Permanent vs. Temporary/Dynamic
- Vital vs. non-Vital
- Single-directional vs. bi-directional

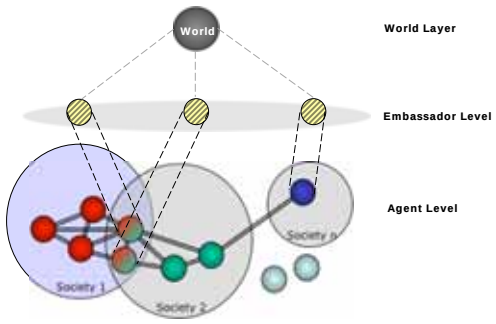
Why are associations needed?

- Avoid communication overhead
- self-configuring, fault-tolerant multi-embedded agent system
- Overcome dimensionality problem in rule bases

Intelligent Association System

Definitions

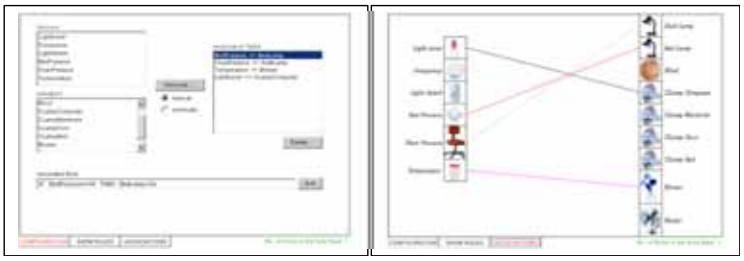
- Agent Societies
  - collection of agents with a common objective goal
- Embassador Agents
  - facilitates communication between societies
  - ability to (re)-combine/dissolve associations



Intelligent Association System

The IAS Editor

- Initial Experiments on manual associations (“connect everything with everything”)
- Three phases of operation:
  - (1) User sets associations manually with the Editor
  - (2) Rule Generation and Agent Control
  - (3) Learning new associations through monitoring



Intelligent Association System

The IAS Editor

- Flow Chart

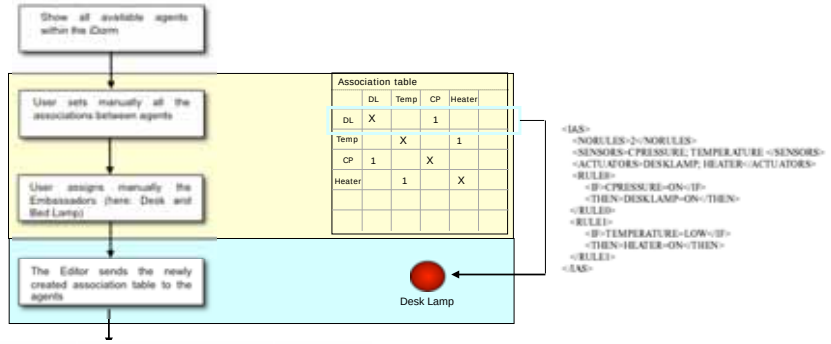


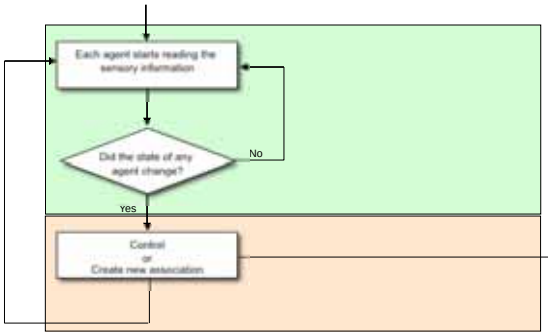
Table 1. Rule base, specified by the user

CPRESSURE	TEMPERATURE	DESKLAMP	HEATER
ON		ON	
	LOW		ON

Intelligent Association System

The IAS Editor

- Flow Chart



Example of two new associations

Bed Pressure -> Bed Lamp
Light Level -> Bed Lamp

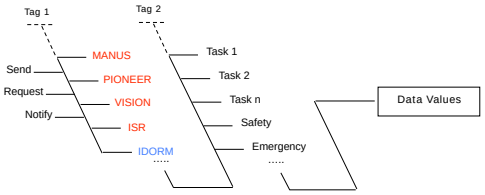
CP	BP	TP	LL	DL	HT	BL
ON				ON		
		LOW			ON	
	ON		LOW			ON

Inter-agent Communication

DIBA*Light*

- Experiments on manually associating agents over long distances

The message format:



Truncations:

Primitive		Tag1: Domain	
S_	SEND	M_	MANUS
R_	REQUEST	P_	PIONEER ROBOT
N_	NOTIFY	V_	VISION (TV)
		ISR_	ISR
		IDORM_	IDORM

Separators:

Tags	_
Information/Values	()
Command	;
Multiple Requests/ Notification	+

Conclusion

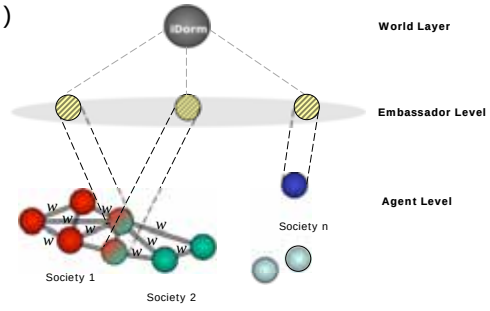
Benefits of learning associations

- Reduces storage and processing capacity, and the communication overhead
- Overcomes the dimensionality problem in rule bases through extracting/deleting rules and modifying the input-output vector
- No requirement of pre-knowledge of the agents existing within the society
- No requirement on expert knowledge for setting up the association, generating the rule base and entering the rules
- Ad-hoc, Fault-tolerant, and self-configuring agent societies without the need of an network operator

Future Work

Calculating learned association weights

- Why is it required to learn association weights?
  - Physical limit of agents might allow only a limited number of connections
- What are the benefits of knowing association weights?
  - Discover better connections dynamically (if the weight is low then this association is of less interest to the system)



Any Questions?

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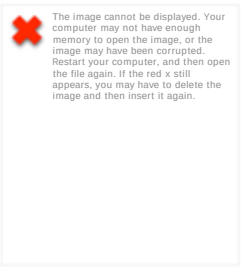

More information can be found on:

http://iieg.essex.ac.uk