Welcome

Introduction to Multiagent Systems

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Introduction

- Recent trends that are happening in computing:
  - ubiquity
  - interconnection
  - intelligence
  - delegation
  - human-orientation

Ubiquity

- Before, computers are large machines situated in large rooms and are very expensive
- Today, computing power can be found almost anywhere on anything and almost anyone has access
- It has increased sophistication and even increased processing power and complexity

Interconnection

- Gone are the days of computers sitting alone on a table
- The internet has become a platform where computers get connected with each other in a networked and distributed environment
- Some researchers have formulated computing models based on interaction

Intelligence

- The tasks being delegated to computers to accomplish have become more complex
- Computers are “more” intelligent than before

Delegation

- Before computers are tools, just like a hammer
- Computers nowadays have been doing things for us without intervention
- We tend to rely more on computers even on critical tasks

Human Orientation

- Computers are no longer treated as mere machines and tools
- Metaphors toward real-world understanding are becoming part of computing
- Ex. Object-Oriented Development, Swarm intelligence, GA, Ant Colony

Programming progression

- Machine code
- Assembly language
- High-level languages
- Subroutines
- Procedures and Functions
- ADT
- Objects
- **Agents**

Global Computing

- More complex problems can be solved by utilizing a huge number of processors, geographically situated
- SETI@home-a scientific experiment that uses Internet-connected computers in the Search for Extraterrestrial Intelligence.

Now what?

- We can build computer systems that can effectively act or our behalf-*delegation* and *intelligence*
- Implies
  - Computer systems should be able to act *independently*
  - Computer systems act to what *represents our best interests* while interacting with other humans or systems

Interconnection and Distribution

- Given *Interconnection* and *Distribution,* together with systems that represent our interests, systems that *cooperate* or *compete* can be built

What is an agent?

- An agent is a computer system that is capable of *independent* action on behalf of its user or owner(figuring out what needs to be done)- *autonomy*

What is a Multiagent System?

- A system that consists of a number of agents that interact with each other
- Agents will be acting on behalf of users with different goals and motivations
- Will require *coordination*, *cooperation*, and *negotiation*

MAS is Interdisciplinary

- Influenced by other fields:
  - Economics
  - Philosophy
  - Logic
  - Ecology
  - Social Sciences
- Both *strength* and a *weakness*

Objection to MAS

- *MAS is just the same as distributed or concurrent systems*
- Agents are autonomous, they can act on their own and are capable of making independent decisions

Objection to MAS

- *MAS is just AI*
- In MAS, there's no need to solve all problems to create useful agents
- Classical AI ignored *social* aspects of agency which is important in real world setting

Notion(weak) of Agency

- *Autonomy*
- *Social Ability*
- *Reactivity*
- *Proactiveness*

Autonomy

- Agents operate without the direct intervention of humans or other agents, and have some control over their actions and internal state

Social Ability

- Agents interact with other agents(possibly humans) via some kind of *agent communication language*

Reactivity

- Agents perceive their environment,(which may be physical world,gui,other agents,the internet, or a combination) and respond in a timely fashion to changes that occur in it

Pro-activeness

- Agents do no simply act in response to their environment, they are able to exhibit goal-directed behavior by taking the initiative

A Stronger Notion

- An agent is a computer system that in addition to the properties described previously is either conceptualized or implemented using concepts that are more usually applied to humans

Other properties

- *Mobility*-movement
- *Veracity*-will not communicate false info
- *Benevolence*-no conflicting goals
- *Rationality*-goal-directed
- *Learning/adaptation*-improve itself

MAS and DAI

- *Distributed Artificial Intelligence(DAI)* is concerned with understanding and modeling action and knowledge in collaborative enterprises.
- Two main areas of DAI are Distributed Problem Solving(DPS) and MAS

DPS and MAS

- DPS considers how the task of solving a particular problem can be divided among a number of nodes that cooperate in dividing and sharing knowledge about the problem and about its evolving solutions
- MAS is concerned with the behavior of a collection of autonomous agents aiming at solving a given problem

A Framework for Research

- Agent Perspective
  - Agent categories, Knowledge structure, Reasoning Abilities, Adaptation and learning abilities,Agent architectures
- Group Perspective
  - Organization, Coordination, Cooperation, Negotiation, Coherent Behavior, Planning, Communication
- Specific Approaches

Agent Architecture

- An agent architecture is the environment where agents are born, live, and die
- A substrate in which the agent is the primitive unit
- Refers to the tying together of everything agent-like into a cohesive whole- from OS to appication level

Why an architecture?

- Agents need an infrastructure because they need a consistent set of rules to follow
- Types of architecture:
  - *Satellite*-implemented in LAN/WAN, focused on problem
  - *Backbone*-agents are distant from each other and spans large networks, focused on mobility

Elements of an agent architecture

- Execution facility
  - Meat of the architecture
  - Runtime environment
- Agent Programming/Specification Languages
- Operating System services
  - Provides access to resources
  - Event driven

Elements of an agent architecture

- Agent native reasoning
  - Reasoning(sensing and acting) is built into the agent instead of a central repository
- Lifecycle services
  - Agent creation
  - Agent naming and agent registry
  - Validation and Verification
  - Agent Termination

Elements of an agent architecture

- Communication
  - Application and Transport Layers
- Mobility and Transport Facility
- Packaging
  - includes:authentication info,state info,goal info,capabilities
- Security

Testbeds

- Testbeds are used to support the implementation of ideas
- Facilities offered:
  - Domain facilities
  - Development facilities
  - Evaluation facilities
- Ex. DVMT,MACE,Tileworld,Phoenix,ARCHO

Some Applications

- Information Retrieval
  - Information overload
  - Filtering
  - Data Mining
- E-commerce (BargainFinder)
- Simulation systems-Urban Planning
- Planning Systems
- Manufacturing

Technologies/Organizations

- Java
- Knowledge Query Manipulation Language
- Foundations for Intelligent Physical Agents
- Various communication protocols in TCP/IP
- Various Frameworks
- Autonomous Agents and Multiagent Systems (AAMAS)

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