Multiagent and Agent Systems (MAAS)

Hochschule Bonn-Rhein-Sieg

b-it Bonn-Aachen International Center for Information Technology

Prof. Dr.-Ing. Gerhard K. Kraetzschmar

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Five Trends in the History of Computing

- Ubiquity
- Interconnection
- Intelligence
- Delegation
- Human-orientation

Ubiquity

- Continual reduction in cost of computing
  makes it possible to introduce processing power into places and devices that would have once been uneconomic.

- As processing capability spreads,
  sophistication (and intelligence of a sort) becomes ubiquitous.

- What could benefit from having a processor in it?

Interconnection

- Computer systems no longer stand alone,
  but are networked into large distributed systems.

- Internet is an obvious example,
  but networking is spreading its ever-growing tentacles.

- Since distributed and concurrent systems have become the norm,
  some researchers are putting forward theoretical models
  that portray computing as primarily a process of interaction.

Intelligence

- The complexity of tasks that we are capable of automating and delegating to computers has grown steadily

- If you do not feel comfortable with this definition of "intelligence", it is probably because you are a human.

Delegation

- Computers are doing more for us … without our intervention
- We are giving control to computers, even in safety-critical tasks
- One example: fly-by-wire aircraft, where the machine's judgment may be trusted more than an experienced pilot
- Next on the agenda: fly-by-wire cars, with
  - intelligent braking systems
  - cruise control that maintains distance from cars in front …

Human-Orientation

- The movement away from machine-oriented views of programming
  towards concepts and metaphors
  that more closely reflect the way we ourselves understand the world

- Programmers (and users!) relate to the machine differently

- Programmers conceptualise and implement software
  in terms of higher-level — more human-oriented — abstractions

Programming Progression

- Machine code
- Assembly languages
- Machine-independent programming languages
- Subroutines
- Procedures and functions
- Abstract data types
- Objects and methods
- …
- Agents and speech acts

Other Trends in Computer Science

- The Grid
- Ubiquitous computing
- Semantic web

The Grid

- The Grid aims to develop massive-scale open distributed systems, able to effectively and automatically deploy and redeploy computational (and other) resources
  to solve large computational problems:
  - huge datasets
  - huge processing requirements

- Current Grid research focussed mainly on middleware

The Grid and Multiagent Systems

- "The grid and agent communities are both persuing the development of such open distributed systems, albeit from different perspectives."
- "The grid community has historically focussed on […] 'brawn': interoperable infrastructure and tools for secure and reliable resource sharing within dynamic and geographically distributed virtual organisations (VOs), and applications of the same to various resource federation scenarios."
- "In contrast, those working on agents have focussed on 'brains', i.e. on the development of concepts, methodologies and algorithms for autonomous problem solvers that can act flexibly in uncertain and dynamic environments in order to achieve their objectives."
- [Foster et al 2004]

Ubiquitous Computing

- "[P]opulations of computing entities – hardware and software - will become an effective part of our environment,
  performing tasks that support our broad purposes
  without our continual direction,
  thus allowing us to be largely unaware of them.
- The vision arises because the technology begins to lie within our grasp.
- This tangle of concerns,
  about future systems of which we have only hazy ideas,
  will define
  a new character for computer science over the next half-century."
- [Milner, 2006]

The Semantic Web

- The semantic web aims to annotate web sites with semantic markup: information in a form processable by computer, typically relating to the content of the web site.
- The idea is that this markup will enable browsers (etc) provide richer, more meaningful services to users.

Berners-Lee on the Semantic Web

- "I have a dream for the web [in which computers] become capable of analysing all the data on the web — content, links, transactions between people and computers."
- "A semantic web", which should make this possible, has yet to emerge, but when it does, the day-to-day mechanisms of trade, bureaucracy and our daily lives will be handled by machines talking to machines."
- "The intelligent agents people have touted for ages will finally materialise."
- [Tim Berners-Lee, 1999]

Agents: A First Definition

- An agent is a computer system that is capable of independent (autonomous) action on behalf of its user or owner (figuring out what needs to be done to satisfy design objectives, rather than constantly being told)

Multiagent Systems: A First Definition

- A multiagent system is one that consists of a number of agents, which interact with one-another.

- In the most general case, agents will be acting on behalf of users with different goals and motivations

- To successfully interact, they will require the ability to
  - cooperate,
  - coordinate, and
  - negotiate
- with each other, much as people do.

The Micro and Macro Problems

- Agent Design
  - How do we build agents
    that are capable of independent, autonomous action
    in order to successfully carry out the tasks that we delegate to them?

- Society Design
  - How do we build agents
    that are capable of interacting (cooperating, coordinating, negotiating)
    with other agents
    in order to successfully carry out the tasks that we delegate to them,
    particularly when the other agents cannot be assumed
    to share the same interests/goals?

Some views of the field

- Agents as a paradigm for software engineering
  - Software engineers have derived
    a progressively better understanding
    of the characteristics of complexity in software.
  - It is now widely recognised
    that interaction is probably the most important single characteristic
    of complex software.
- Agents as a tool for understanding human societies
  - Multiagent systems provide a novel tool for simulating societies,
    which may help shed some light on various kinds of social processes.

Objections to MAAS

- Isn’t it all just distributed/concurrent systems?
- Isn’t it all just artificial intelligence?
- Isn’t it all just economics / game theory?
- Isn’t it all just social science?