Motivation

- Distributed computing, WWW
- Need interoperability
- Open systems
- Need for adaptability, robustness
- Work with huge amount of mostly unstructured information
Agent-Oriented Computing

- View a distributed computing system as a society of agents
- Agents are autonomous

Key Agent Technologies

- Yellow pages, matchmakers, brokers
- Agent communication languages
- Coordination protocols
- Ontologies, semantic markup languages
- Communication infrastructure
- Agent programming languages & architectures
Attributes of Agents

- Autonomous
- Reactive
- Proactive
- Have social abilities

Typical Applications

- Industry: Air-traffic control, electricity distribution management
- E-commerce: shopping agents, supply chain integration
- Personal assistants: meeting scheduling, movie/book selection
- Information management: mail/news filtering, information retrieval
- Intelligent interfaces & groupware
- Robotics: Deep Space I, museum guides, soccer
- Believable agents for entertainment & games
Need for Intelligence in Agents

- Hard to predict all tasks and behaviors in advance
- To get adaptability, need to use AI techniques
- Agents must be able to make new plans to achieve their goals, cope with failures, reason about other agents

E.g. IndiGolog

- High-level programming language for robots and intelligent agents (U of T, York, Rome, etc.)
- Based on situation calculus, logic for reasoning about dynamic worlds
- Supports online/offline planning and plan execution in dynamic and incompletely known environments
- Supports complex behavior specifications
- Supports ordinary, sensing, exogenous actions
- Implemented on top of Prolog
IndiGolog Agent Structure (1)

- Declarative Part – Application domain dynamics specification in situation calculus

- Includes:
  - Axioms describing initial situation
  - Action precondition axioms
  - Successor state axioms
  - Sensed fluent axioms
  - Unique names axioms for actions
  - Foundational, domain independent axioms

IndiGolog Agent Structure (2)

- Procedural Part – Rich set of constructs for agent behaviour specification
  - Recursive Procedures
  - If-then-else
  - While loops
  - Non-deterministic branch / choice of arguments / iteration
  - Concurrency with or without priorities
  - Interrupts
  - Search block
E.g. Multirobot Mail Delivery

- Varying number of robots
- Dispatcher agent assigns incoming orders to mail robots
- Dispatcher, robots implement a variation of contract net protocol
- Robots – two agent architectures
  - High-Level Control (HLC) in IndiGolog – bidding, optimal route planning
  - Low-Level Control (LLC) – motion subsystem
- Also: GUI, PathPlanner, DB
HLC – Behaviour Specification

```
proe(control, [ ]
    prioritized_interrups([ ]
        % high priority interrupt: handles bid requests
        interrupt([f,t,o],
            bid_requested(f,t,o)=true,
            pl([l,d], (l=next_location),
            (d=dist(l,f)), bid(o,d)))),
        % medium priority interrupt: handles newly assigned orders
        interrupt([f,t,o], and(canmove,
            delivery(f,t,o)=ordered),
            search(pconc(minimize_distance(0), envSimulator)))),
        % low priority interrupt: when nothing to do, wait
        interrupt(true, no_op)
    ])
)
```

Winter 2012

E.g. Lights and Camera Project

- Intelligent control of image acquisition, lights and camera settings
- Applications in space, mining, surgery
Lights and Camera Architecture

Intelligent Controller

next light settings, vision parameters

evaluation metrics, e.g. model matching error

Vision Server

Edge Detection → Edge Linking → Pose Estimation

lights and camera parameters

corresponding image

Image Server

Acquisition → Simulation

parameters

images

Acquisition → Simulation

parameters

images

My Group’s Current Research

- Agent-programming languages & tools
- Planning in dynamic incompletely known domains
- Cognitive vision/robotics
- Semantic web, web services
- AO software engineering & formal methods
References