YORK UNIVERSITÉ UNIVERSITY

# CSE 3402 Intro to AI

# Intelligent Agents and Multiagent Systems

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## 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)

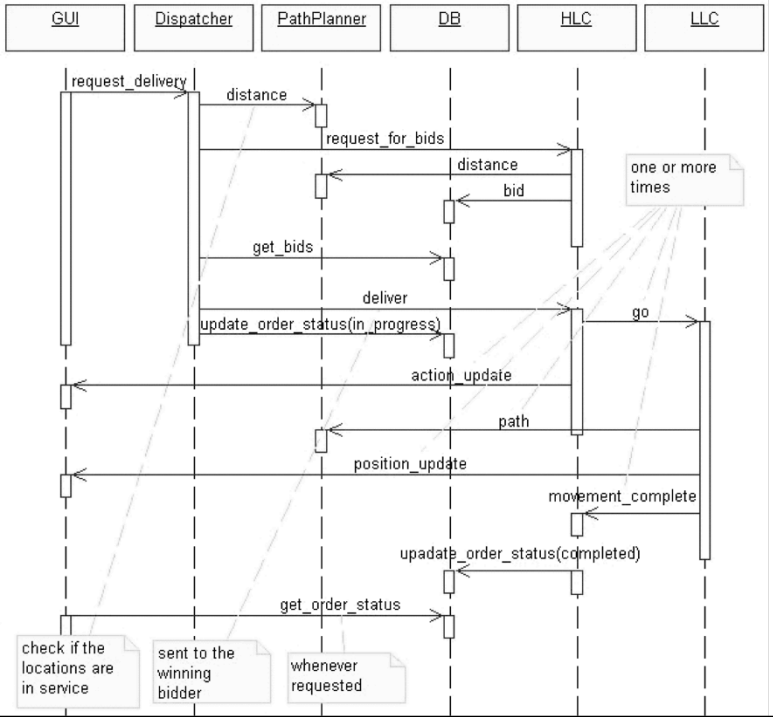
- Procedural Part – Rich set of constructs for agent behaviour specification
  - Recursive Procedures
  - If-then-else
  - While loops
  - Non-deterministic branch / choice of arguments / iteration
  - Concurrency with or without priorities
  - Interrupts
  - Search block

# 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



Interactions



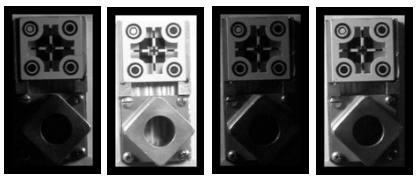
# HLC – Behaviour Specification

```
proc(control, [
   prioritized_interrupts([
        %high priority interrupt: handles bid requests
        interrupt([f,t,o],
                bid_requested(f,t,o)=true,
                pi([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)
   ]) ]).
```

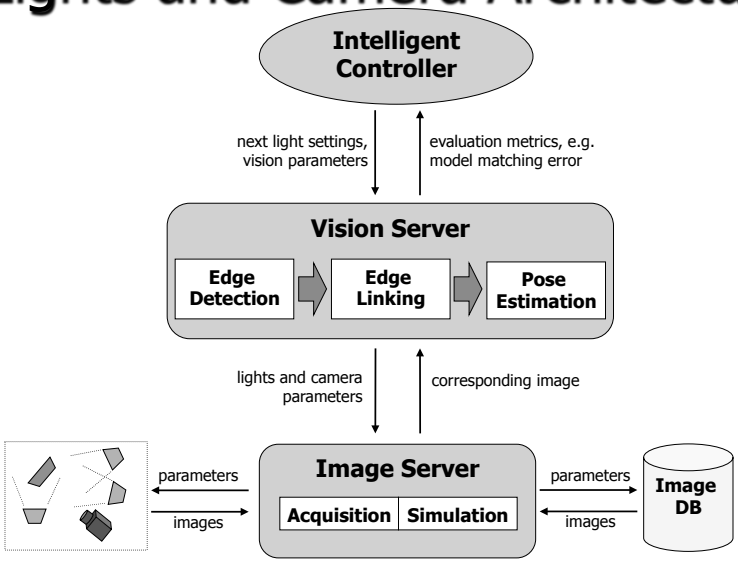


# E.g. Lights and Camera Project

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



# Lights and Camera Architecture






# 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


- Wooldridge M., *An Introduction to Multiagent Systems*, Wiley, 2002.
- A. Lapouchnian and Y. Lespérance. Interfacing IndiGolog and OAA - A Toolkit for Advanced Multiagent Applications. *Applied Artificial Intelligence* **16**(9-10), 813-829, 2002.
- O. Borzenko, W. Xu, M. Obsniuk, A. Chopra, P. Jasiobedzki, M. Jenkin, and Y. Lespérance. Lights and Camera: Intelligently Controlled Multi-channel Pose Estimation System. *Proc. of IEEE Int. Conference on Vision Systems (ICVS'06)*, paper 42 (8p), New York, 2006.