

New Slides

Coordinated Problem Solving

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Distributed Computing vs. Distributed AI Viewpoints

- Distributed Computing
 - Tightly coupled, parallelization, centralized control
 - [Distributed OS] Independent processes
 - Resource coordination: centralized locking, load balancing
 - Total database consistency
- Distributed AI
 - Loose coupling, distributed control
 - Interdependent processes (data coordination)
 - “Functionally Accurate” (often inconsistent)

Coordinating Computational Actions

- Abstraction
 - Goals
 - Plans
 - Schedules
- Location
 - Centralized
 - Decentralized
- Learning
 - Static
 - Dynamic
- Structure
 - Implicit
 - Explicit

Coordination and Planning

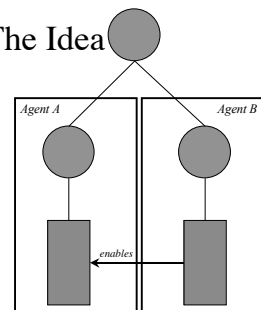
- Plan Merging Analyses
 - Given complete plans, look for cross plan threats (dropping or abstracting away independent parts)
- Plan Combination Search [Ephrati & Rosenschein]
 - Refine set of all possible local plans by working through a global state space one step at a time
- Hierarchical Behavior-space Search [Durfee & Montgomery]
 - Work out joint plan at highest level of detail, resolve conflicts at next more specific level

Partial Global Planning [Durfee]

- Assume that tasks are interrelated, but not known a priori
- Develop a local abstract plan in terms of goal sequences
- Communicate to other agents (using meta-level organization)
- Identify partial global goals between abstract plans
- Create new, partial global plans from local plans and send them back to the appropriate agents

GPGP: The Idea

- Have A wait and see (poll)
- Have A ask B
 - “If”
 - “When”
- Have B tell A
 - B sends result when available
 - B commits to a deadline by which it will send the result
- Etc.



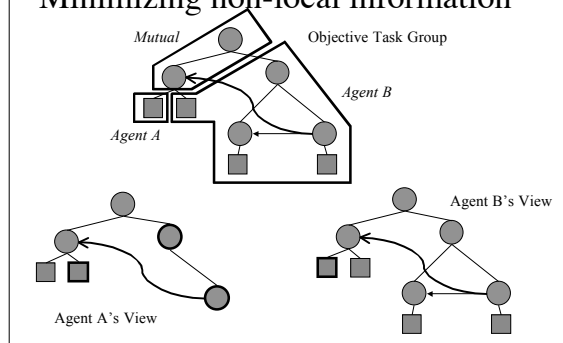
Some Coordination Mechanisms for Enablement

- Avoidance (with/without quality sacrifice);
- Reservation schemes;
- Simple predecessor-side commitments (to do in future time point, do by deadline, do after EST);
- Simple successor-side commitments;
- Polling approaches (busy querying, timetabling, constant headway);
- Shifting task dependencies by learning or mobile code (promotion/demotion shift);
- More complex multi-stage negotiation strategies;

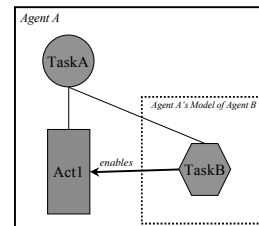
Other Coordination Mechanisms

- Redundant tasks (more than one agent under an OR node)
 - Avoidance
 - Load balancing
- Soft Facilitation
 - Predecessor commitment
- Mutual Exclusive Resources
 - Simple bidding

Minimizing non-local information

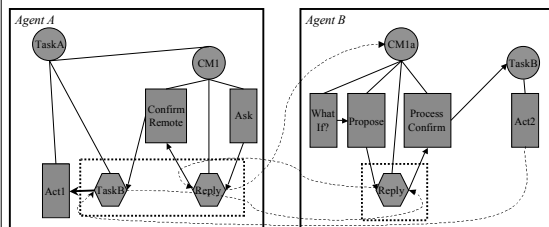


Example: Coordination by Reservation



What is Act1's Quality, Cost, Duration?
Does Agent B even know I need Act2?

Example: Coordination by Reservation

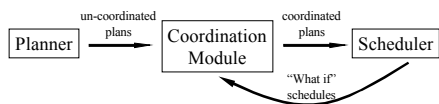


1. When can you finish TaskB? [GPGP Reservation CM Protocol]
2. Commit TaskB finish at time t1, quality 34, cost 6.
3. Agreed.
4. Here is TaskB's result.

Implementation

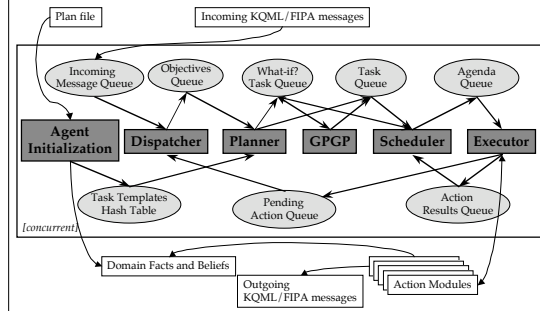
- Assume agent has local scheduling capability
 - Attempt to maximize utility (self, shared, whatever) by future action sequence
 - Problem is non-local effects make schedule more uncertain or simply unknown (I can't start my task until Agent B does Task B)
- Other assumptions needed for full range of mechanisms
 - Some way to do "what-if" schedule reasoning
 - Ability to make commitments to do, don't, and do w.r.t earliest start times and deadlines
 - Ability to move code for action promotion/demotion

Coordination Module

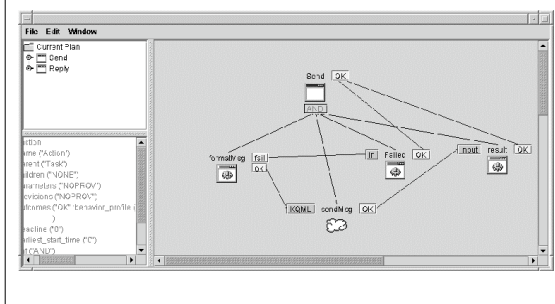


Coordination Module takes advantage of the local scheduler's scheduling ability to evaluate/estimate the features of actions for the remote agents.

DECAF Architecture



Plan Editor



Summary: Coordination

- Process of managing the interdependencies between activities
 - Choice of actions
 - Ordering of actions
 - Timing of actions
- Difficulties occur because of uncertainties
 - Incomplete view (partly inaccessible state)
 - Dynamic situation
 - Action outcome nondeterminism

Summary: Coordination Mechanisms

- Explicitly negotiated commitments, schedules, plans
- Explicit or implicit laws, rules, behavioral norms
- Long-term, generalized versions of the above
 - organizations, roles, standard operating procedures

Summary: Mechanism design space

- Abstraction
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Summary: (Mostly) Implicit Approaches

- Social Conventions
 - Standardization
 - Slack
 - Rules/Social Laws
 - Forecasting
 - Benevolence
- Agent Modeling
 - Game Theory
 - RMM
 - Markets
 - Observation
- Organizations
 - Authority/ hierarchy
 - Standard Operating Procedures (Business Processes)
 - Specialization
 - Professionalization
 - Informal channels
 - Vertical Integration
 - Structured Communities
 - Teams

Summary: (Mostly) Explicit Approaches

- Commitments
 - Distributed goal search
 - Types of commitments
 - Concept
 - Related constraints
 - Joint Commitment
 - Conventions
- Planning
 - Centralized
 - Plan merging
 - Plan Synchronization
 - Scheduling (continuum w/ planning)
 - Partial Global Planning
 - Other Distributed Scheduling Approaches

Summary

- Coordination: locally choosing and temporally ordering actions
- TÆMS: representing coordination problems
- GPGP: mechanisms for dealing with coordination problems
- DECAF: agent building toolkit [<http://www.cis.udel.edu/~decaf>]
- Information gathering applications in finance & bioinformatics [<http://udgenome.ags.udel.edu/>]

<http://www.cis.udel.edu/~decker>