

The Pickup and Delivery Problem

Intelligent Agents
Course 2018/2019

Pickup and Delivery Problem PDP

- Constrained (multiple) Travelling Salesman Problem
- Logistic company with a fleet of trucks
- Goal: satisfy customer requests:
 - loads have to be transported from their origin location to their delivery point
- Goal: optimize profit
- Several constraints can be added to the problem, such as the costs of the vehicles and crews or the fuel capacities

Real World Problem!

- Real problem:
 - Companies are applying agent technology to Logistics

Classical Approach	Agent Systems
Large hierarchical apps	Societies of Small Agents
Batch	Real-time
Sequential Processing	Concurrent
Follow instructions	Negotiations on-the-fly
Static	Dynamic



Environment

Topology of Cities:

Cities (nodes)
connected with roads
(edges)

Coordinates & distances

Not dynamic

Satisfying Customer Requests

- Customer requests:
 - Tasks are spread over the topology
- Transportation tasks:
 - Pickup city
 - Delivery city
 - Weight in kg
 - Reward in CHF

Lifecycles and Companies

- **Logistic companies (1 or more) :**
 - Owns one or more trucks
 - Fulfill customer requests
- **Lifecycle:**
 - Working without interruption
 - until all tasks delivered
 - Exception: reactive agent will travel all the time

Vehicles

- Fixed load capacity
- One or more tasks at a time
- Starting place
- Obligated to deliver a task to its destination
- Cost for a specific task: *function(route)*

Planners/Behaviors

- «Brain» of the intelligent agents
- decide what to do at every time step
- 4 planners to implement -> 4 exercises
 - Vehicle planners:
 - Reactive planner/behavior for a reactive agent;
 - Deliberative planner/behavior for a deliberative agent;
 - Company planners:
 - Centralized planner of cooperative agents;
 - Decentralized planner of self-interested agents.

Exercises configurations

Exercise	Company	Vehicles	Tasks	Planner
Reactive Agent	1 company	N Reactive agents Move through the topology, sensing tasks	Spread out in the topology	Reactive planner: sensing function of tasks; selects actions on the basis of a learned state-action table
Deliberative Agent	1 company	1 Deliberative ag. Implements an optimal plan with state-based search algorithm.	Spread out in the topology	Deliberative planner: models all possible states; returns optimal plan
Centralized Coordination	1 company establishes a centralized plan for its cooperative vehicles	N veh. move with assigned tasks	Spread out in the topology	Centralized planner: models a constraint satisfaction problem
Distributed Coordination	N companies compete through an auction for tasks	Each company has its vehicles	Tasks attributed to different companies & exchanged through auctions	Decentralized planner prescribes a bidding strategy & computes plans for vehicles

LogistPlatform

- A simulation platform for the Pickup and Delivery Problem
- Implements the PDP as presented
- Built on RePast
 - Discrete scheduler
 - Dynamic visualization
- Version 1.0

LogistPlatform (continued)

- 3 configuration files:
 - e.g. topology.xml, reactive.xml, tasks.xml
- topology configuration file specifies the routes
- tasks configuration file specifies probabilities/tasks
- reactive.xml (deliberative.xml, ...) specifies the framework setup, for example the classpath to behaviors, number of agents and their parameters
- Helps implement custom agent behaviors
 - Act upon signals and generate appropriate responses
 - interface with the platform in order to create more sophisticated behaviors (e.g. auction).