

# The Pickup and Delivery Problem

Intelligent Agents



## Pickup and Delivery Problem PDP

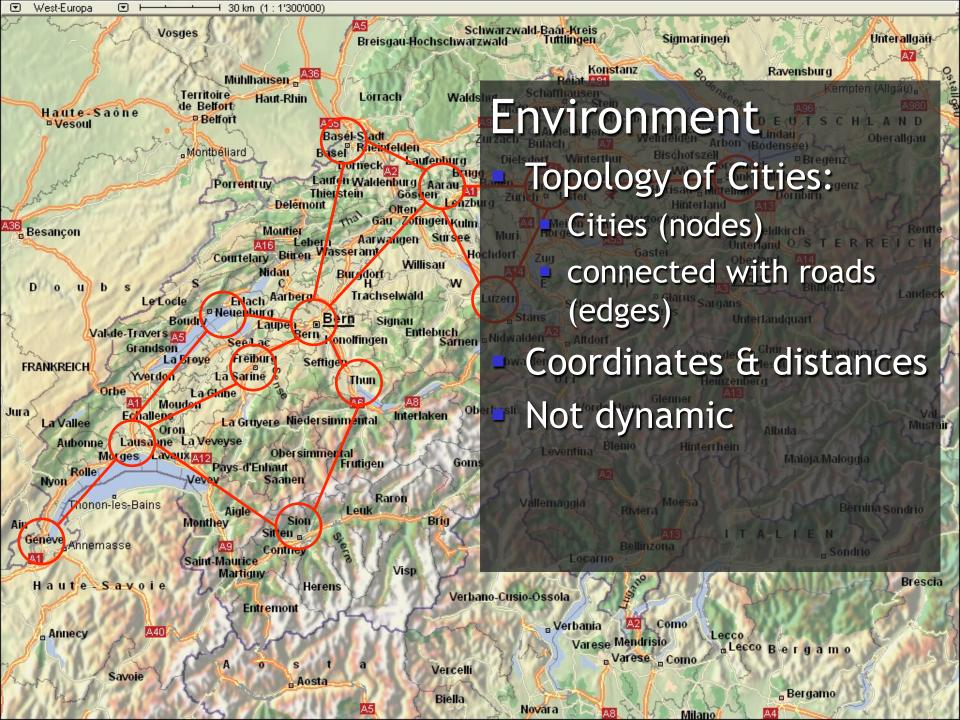
- Constrained (multiple) Travelling Salesman Problem
- Logistic company with a fleet of trucks
- Goal: satisfy customer requests:
  - loads have to be transported from their origin location to their delivery point
- Goal: optimize profit
- Several constraints can be added to the problem, such as the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





# **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
- Obliged 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	
Delibe- rative 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	
Centra- lized Coordi- nation	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	
Distri- buted Coordi- nation	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).

