The Pickup and Delivery Problem

Intelligent Agents
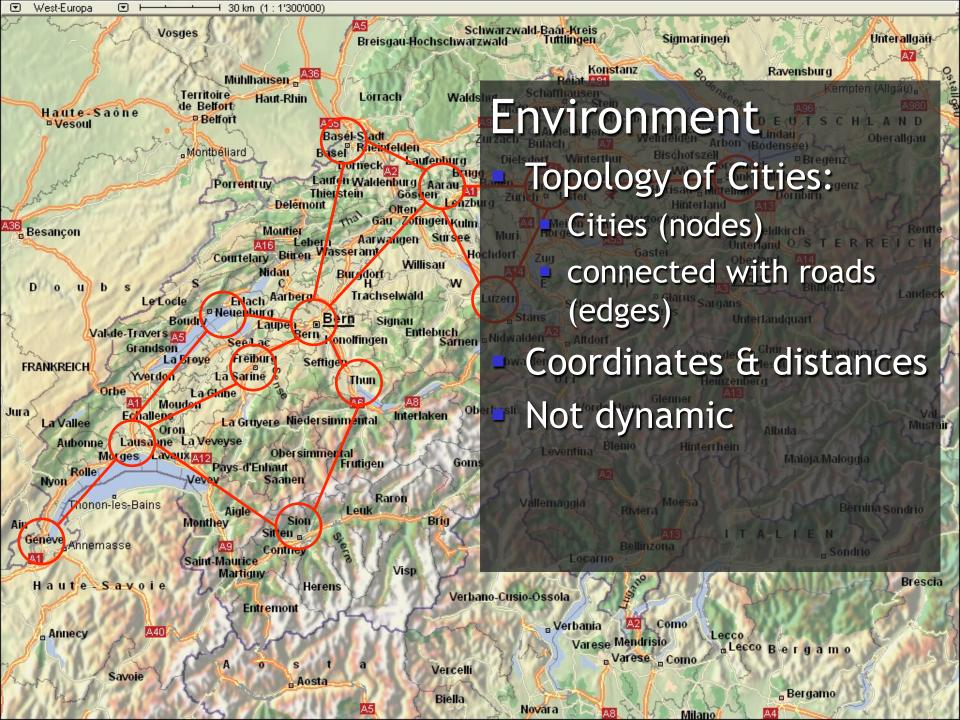*Course 2018/2019*

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

- Several constraints can be added to the problem, such as the costs of the vehicles and crews or the fuel capacities

- GOAL: optimize profit

Real World Problem!

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

Classical Approach	Agents 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
  - Loads in kg
  - Reward in CHF

Lifecycles and Companies

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

Vehicles

- Fixed load capacity

-   In some exercises, several loads at a time

- Starting place

- Obliged to deliver a load to its destination

- Cost function for a specific task:
    function(route)

Planners/Behaviors

- «Brain» of the intelligent agents
- used to compute advanced plans
- 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
- Implement custom agent behaviors, which act upon signals and generate appropriate responses
- Implement custom agents, which can interface with the plarform in order to create more sophisticated behaviors (e.g. auction).

Reactive Agent Exercise

- Study simple aspects of LogistPlatform (behaviors, configuration files)
- Program the Reactive Agent