G54DIA: Designing Intelligent Agents

Lecture 8: Hybrid Architectures II

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Outline of this lecture

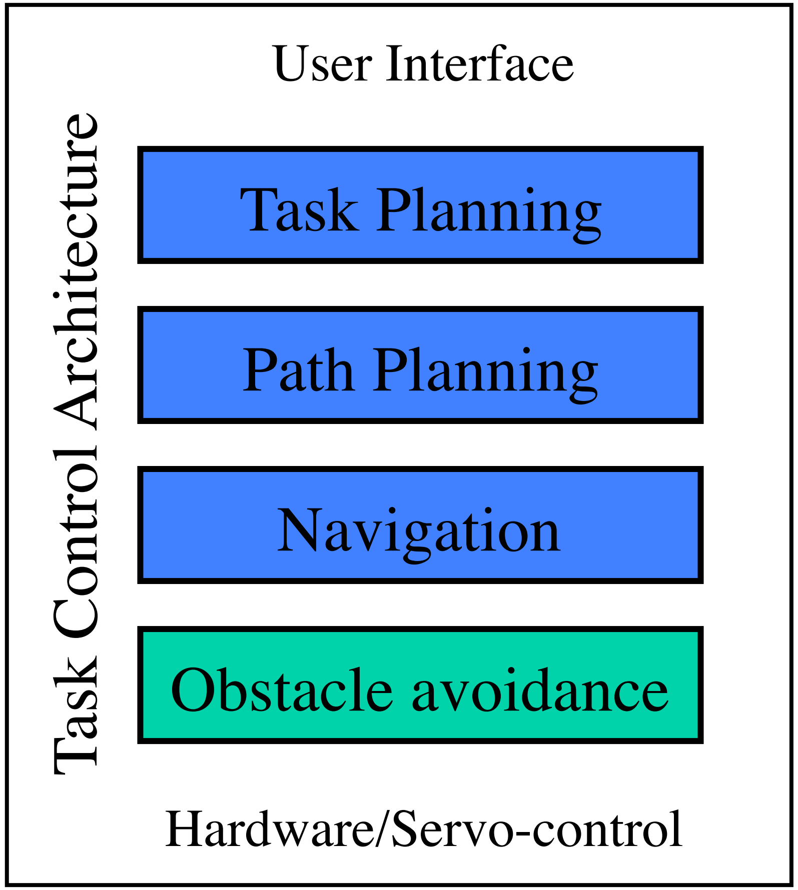
- another example of hybrid architecture: Xavier
- early module feedback

Xavier's percepts and actions

- sensors:
  - bump panels
  - odometers
  - 24 sonar sensors
  - front-pointing laser striper
  - colour camera
- actuators:
  - 4 drive wheels
  - speech output
  - Wavelan wireless ethernet card

- on-board processing: two 66MHz i486 computers & a i486 laptop (all running Linux)

Xavier's architecture



Task planning

- task planning is performed using the PRODIGY partial order planner
- integrates new asynchronous requests into the current plan
- prioritises tasks
- opportunistically achieves compatible tasks
- determines the order in which to interleave the actions required for each task
- consults the path planner to determine the expected travel time between two locations

Path planning

- determines how to travel efficiently from one location to another
- uses a decision theoretic approach to choose plans with high expected utility
- uses sensitivity analysis to determine which alternatives to consider
- actuator and sensor uncertainty complicates path planning
  - the robot may not be able to follow a path accurately
  - the shortest distance path is not necessarily the fastest

Navigation

- navigation layer directs the robot to a given goal location
- uses Partially Observable Markov Decision Process models
- maintains a probability distribution of where the robot is at all times and chooses actions based on that distribution
- generally follows the path suggested by the path planner
- it may deviate from the desired path since it has to deal with sensor and motor uncertainty–if an error is detected, it issues corrective actions that re-orient the robot towards its goal

Obstacle avoidance

- obstacle avoidance is performed using a curvature velocity method
- keeps the robot moving in the desired direction, while avoiding static and dynamic obstacles (e.g., tables and people)
- takes the robot's dynamics into account
- real time optimisation problem that combines safety, speed and progress along the desired heading

Integration

- reliability and efficiency is achieved using reliable and efficient components and through the interaction of the layers
- each layer uses a more abstract representations of the data from lower layers
- higher layers can guide the lower layers into regions of the environment where safe and efficient navigation can take place
- lower layers take care of details abstracted away by higher layers
- lower layers propagate failures up to higher layers when they find they can't handle certain exceptional situations

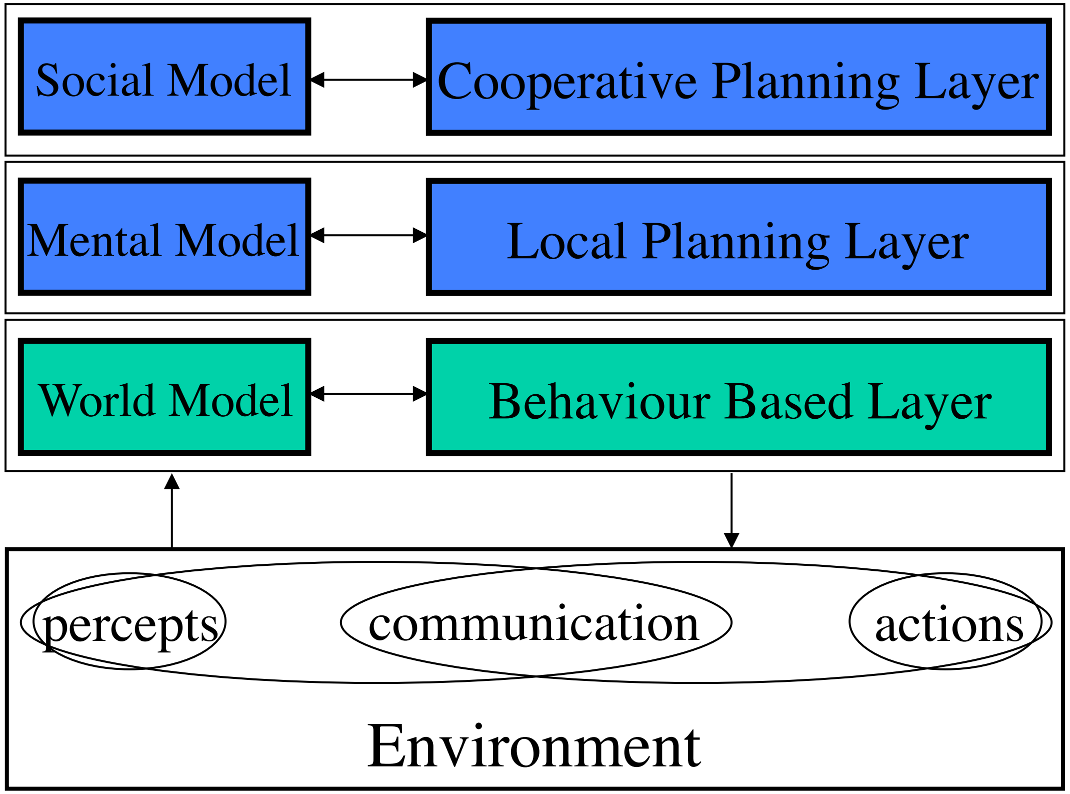
Xavier's task environment

Xavier takes the elevator

Example: InteRRaP

- InteRRaP is a hybrid architecture which integrates behaviour-based control, deliberation and joint planning
- used in FORKS—a software and hardware simulation of an automated loading dock
- agents receive orders to load and unload trucks
- while performing their tasks they may run into conflicts with other agents, e.g., if both agents try to move to the same place at the same time

InteRRaP architecture



InteRRaP layers

The architecture is has three layers:

- *behaviour-based layer* allows the agent to react to critical situations (using reactor *patterns of behaviour*) and to deal with routine situations (using procedure *patterns of behaviour*)

- *local planning layer* allows the agent to do domain dependent planning, using information from the *world model* together with the agents current goals and intentions held in the *mental model*

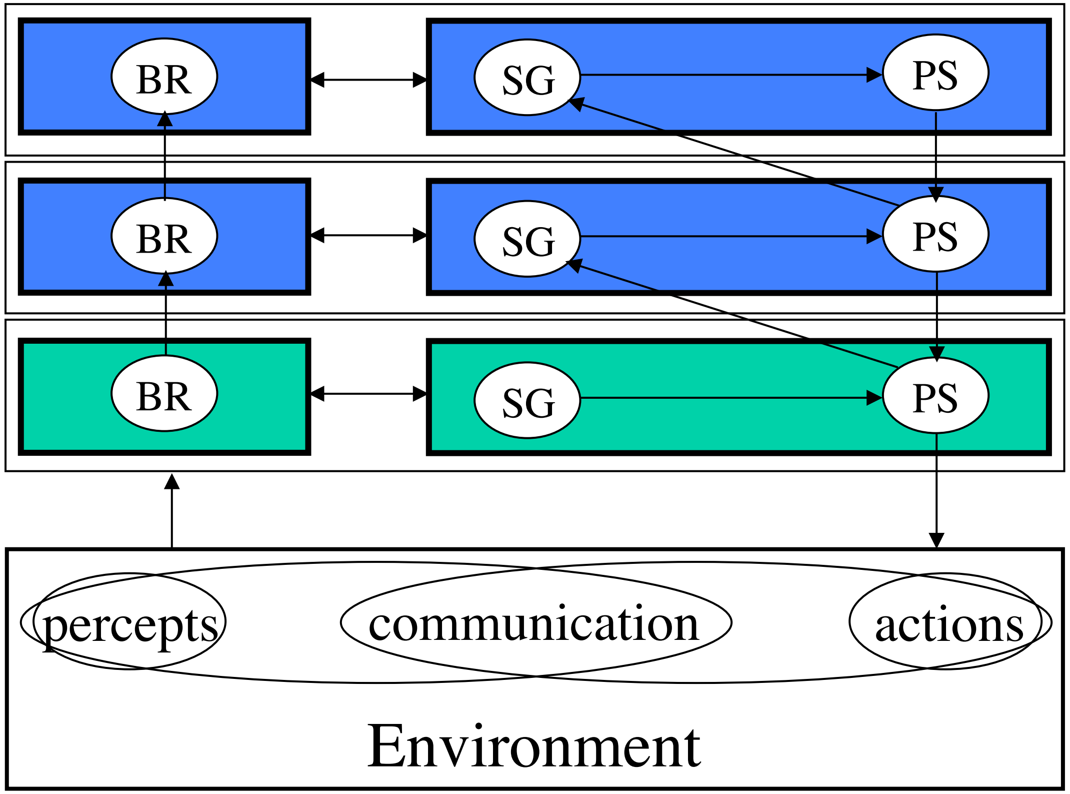
- *cooperative planning layer* extends the planning functionality to joint plans, i.e., plans involving multiple agents which resolve conflicts and allow the agents to cooperate

InteRRaP layer functions

Each layer implements 3 functions:

- Belief Revision (BR): belief revision and knowledge abstraction, which maps the agent's current percepts and old beliefs to new beliefs
- Situation Recognition and Goal Activation (SG): derives new goals from the agent's new beliefs and its current goals
- Planning and Scheduling (PS): derives a set of new intentions (commitments to courses of action) based on the agent's current goals (selected by SG) and the agent's current intentions

InteRRaP architecture detail



The next lecture

Description of Coursework 1