Overview

Agent Architectures

Definition
of agent architecture

“Classical” Architectures for robots
consists of functional components

Situated Automata
eliminates explicit deliberation

Behavior-Based Architectures
behaviors as essential components

Agent Infrastructure
Agencies

Agent Lifecycle
Creation, Registration, Termination
Agent Architecture

Definition

The architecture of an agent defines how the job of generating actions from percepts is organized (adapted from [?], p. 786)

Variations for different types of agents

- abstract vs. concrete
- classical vs. behavior-based
- reflex / goal-based
- knowledge-based
- planning
- learning
- ...

this is a widely open field, there is no accepted theory of agent architectures or architecture design
Abstract Architectures

formalization of agent descriptions

environment
  described through a set of environment states

actions
  set that describes the effectoric capabilities of an agent
  most agents have an effect on the environment (state change)

history
  sequence of transitions that describes the interaction between an agent and the environment

an agent can be described through a function that maps sequences of environment states to actions
Concrete Architectures

implementations of state and actions

logic-based agent
  decision-making is realized through logical deduction
  also referred to as symbolic AI

reactive agents
  decision-making is based on mappings from situation to action
  one instance is the subsumption architecture suggested by Rodney Brooks
  basic behaviors are associated with tasks behavior-based agents
  agent is situated in a particular environment

belief-desire-intent agents
  decisions are based on data structures that represent the beliefs, desires, and intentions of an agent

layered architectures
  software layers with different levels of reasoning about the environment
“Classical” Architectures

mainly for autonomous robots

agent design
functional components are used as building blocks,
e.g. perception, learning, planning

functional module
receives specific information from sensors or other modules, processes it, and delivers
results to effectors or other modules

world model
centralized, complete

taskable
a goal can be assigned, and a plan to achieve it can be carried out by the agent

learning
explanation-based, mainly via compilation of used plans

Principal drawback: Explicit reasoning about the effects of low-level actions is too
desirable to generate real-time behavior
Shakey

an example of a classical robot architecture

vision system
  for simple object location

path-planning algorithm
  two-dimensional

theorem prover
  constructs simple symbolic plans based on the situation calculus

physical components
  wheels, motors, sensors, processors

Several improvements for later versions, mainly through special-purpose components (low-level actions, LLAs) and plan compilation (macro-operators)
**Situated Automata**

concise specification of simple agents

**finite-state machine**
- input from sensors, outputs to effectors

**reflex agents**
- essentially efficient implementations of reflex agents with state

**explicit knowledge representation**
- generates the automaton by an offline compilation process

**decomposition**
- manual design process according to various necessary behaviors

**Goal:** Eliminate explicit deliberation

**Problem:** Sometimes it is necessary
Behavior-Based Robotics

behaviors as building blocks

**agent design**
composed from basic behaviors,
e.g. obstacle avoidance, wall-following, exploration

**behavioral module**
accesses sensors independently, evaluates information, sends signals to effectors

**prioritized hierarchy**
“higher” behaviors can override “lower” ones

**world representation**
no need for a centralized, complete representation
“the world is its own model”

Single, inexpensive mechanism that can achieve many basic competences in the world.

Problem: A new task requires a complete redesign of the agent
Agencies

Infrastructure for agents

location
  a place where agents can "live"
  not necessarily a physical entity

registration
  keeping track of agents at an agency

services
  an agency often serves as a market place for agents that utilize and offer services

control
  resources, agent behavior

expenses
  agencies often provide a mechanism to pay and charge for services
Agent Lifecycle

creation
usually initiated by the user
sometimes agents “spawn” other agents

registration with agencies
model for providing and utilizing services

termination
task is finished
agent is out of control

task definition
a new task can be assigned to the agent

mobility
may be viewed as multiple lifecycles at different locations (agencies)
Summary - Agent Architectures

how to organize the generation of actions from percepts

**variations** for different types of agents  
classical, behavior-based, reflex, goal-based, . . .

**classical architectures**  
functional components as building blocks

**situated automata**  
formal, concise specification of simple agents

**behavior-based agents**  
basic building blocks are behaviors  
no centralized world model