Computational Intelligence

A Logical Approach

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Lecture Overview

➤ What is Computational Intelligence?

➤ Agents acting in an environment

➤ Representations

What is Computational Intelligence?

The study of the design of **intelligent agents** .

An **agent** is something that acts in an environment.

An **intelligent agent** is an agent that acts intelligently:

➤ its actions are appropriate for its goals and circumstances

➤ it is flexible to changing environments and goals

➤ it learns from experience

➤ it makes appropriate choices given perceptual limitations and finite computation

Artificial or Computational Intelligence?

➤ The field is often called **Artificial Intelligence.**

➤ **Scientific goal:** to understand the principles that make intelligent behavior possible, in natural or artificial systems.

➤ **Engineering goal:** to specify methods for the design of useful, intelligent artifacts.

➤ Analogy between studying flying machines and thinking machines.
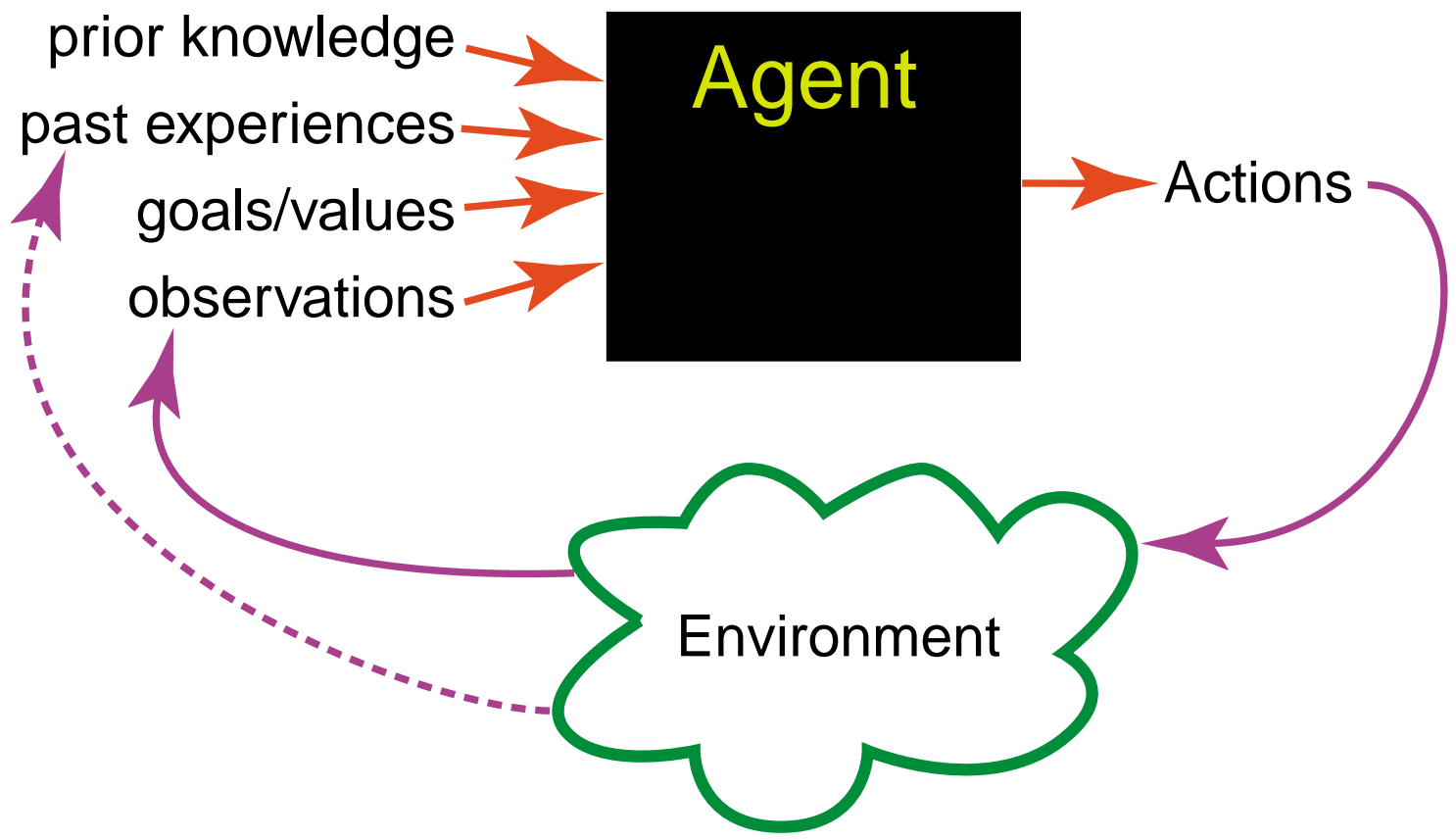
Central hypotheses of CI

Symbol-system hypothesis:

➤ Reasoning is symbol manipulation.

Church–Turing thesis:

➤ Any symbol manipulation can be carried out on a Turing machine.

Agents acting in an environment

prior knowledge →

past experiences →

goals/values →

observations →

Agent

→ Actions

Environment

Example agent: robot

➤ **actions:** movement, grippers, speech, facial expressions,…

➤ **observations:** vision, sonar, sound, speech recognition, gesture recognition,…

➤ **goals:** deliver food, rescue people, score goals, explore,…

➤ **past experiences:** effect of steering, slipperiness, how people move,…

➤ **prior knowledge:** what is important feature, categories of objects, what a sensor tell us,…

Example agent: teacher

➤ **actions:** present new concept, drill, give test, explain concept,…

➤ **observations:** test results, facial expressions, errors, focus,…

➤ **goals:** particular knowledge, skills, inquisitiveness, social skills,…

➤ **past experiences:** prior test results, effects of teaching strategies, …

➤ **prior knowledge:** subject material, teaching strategies,…

Example agent: medical doctor

➤ **actions:** operate, test, prescribe drugs, explain instructions,…

➤ **observations:** verbal symptoms, test results, visual appearance…

➤ **goals:** remove disease, relieve pain, increase life expectancy, reduce costs,…

➤ **past experiences:** treatment outcomes, effects of drugs, test results given symptoms…

➤ **prior knowledge:** possible diseases, symptoms, possible causal relationships…

Example agent: user interface

➤ **actions:** present information, ask user, find another information source, filter information, interrupt,…

➤ **observations:** users request, information retrieved, user feedback, facial expressions…

➤ **goals:** present information, maximize useful information, minimize irrelevant information, privacy,…

➤ **past experiences:** effect of presentation modes, reliability of information sources,…

➤ **prior knowledge:** information sources, presentation modalities…
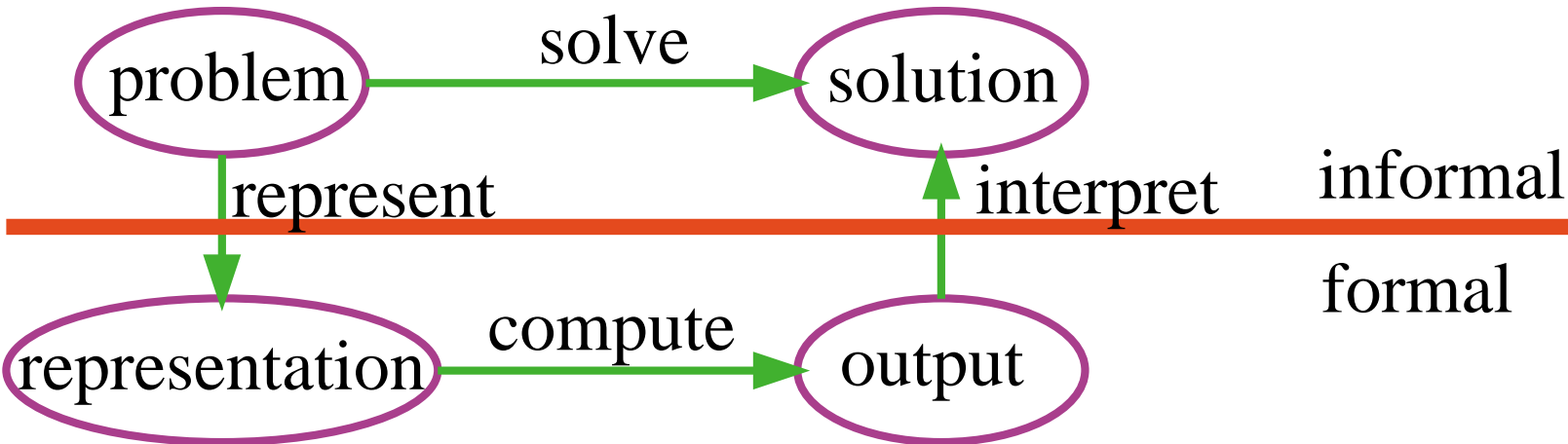
Example representations: machine language, C, Java, Prolog, natural language

What do we want in a representation?

We want a representation to be

➤ rich enough to express the knowledge needed to solve the problem.

➤ as close to the problem as possible: compact, natural and maintainable.

➤ amenable to efficient computation;
able to express features of the problem we can exploit for computational gain.

➤ learnable from data and past experiences.

➤ able to trade off accuracy and computation time.

Representation and Reasoning System

Problem $\Longrightarrow$ representation $\Longrightarrow$ computation

A representation and reasoning system (RRS) consists of

➤ Language to communicate with the computer.

➤ A way to assign meaning to the symbols.

➤ Procedures to compute answers or solve problems.

Example RRSs:

➤ Programming languages: Fortran, C++,…

➤ Natural Language

We want something between these extremes.