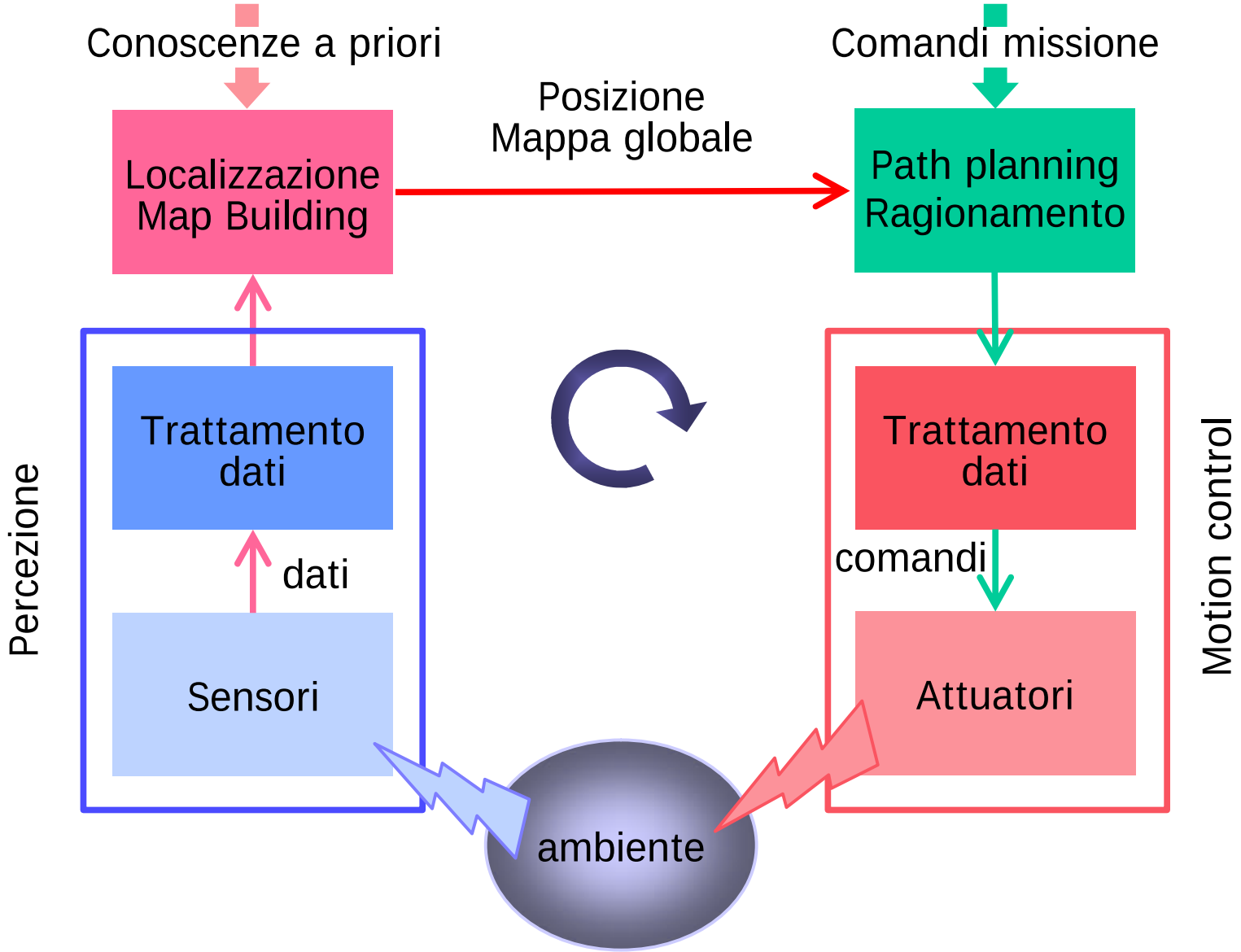
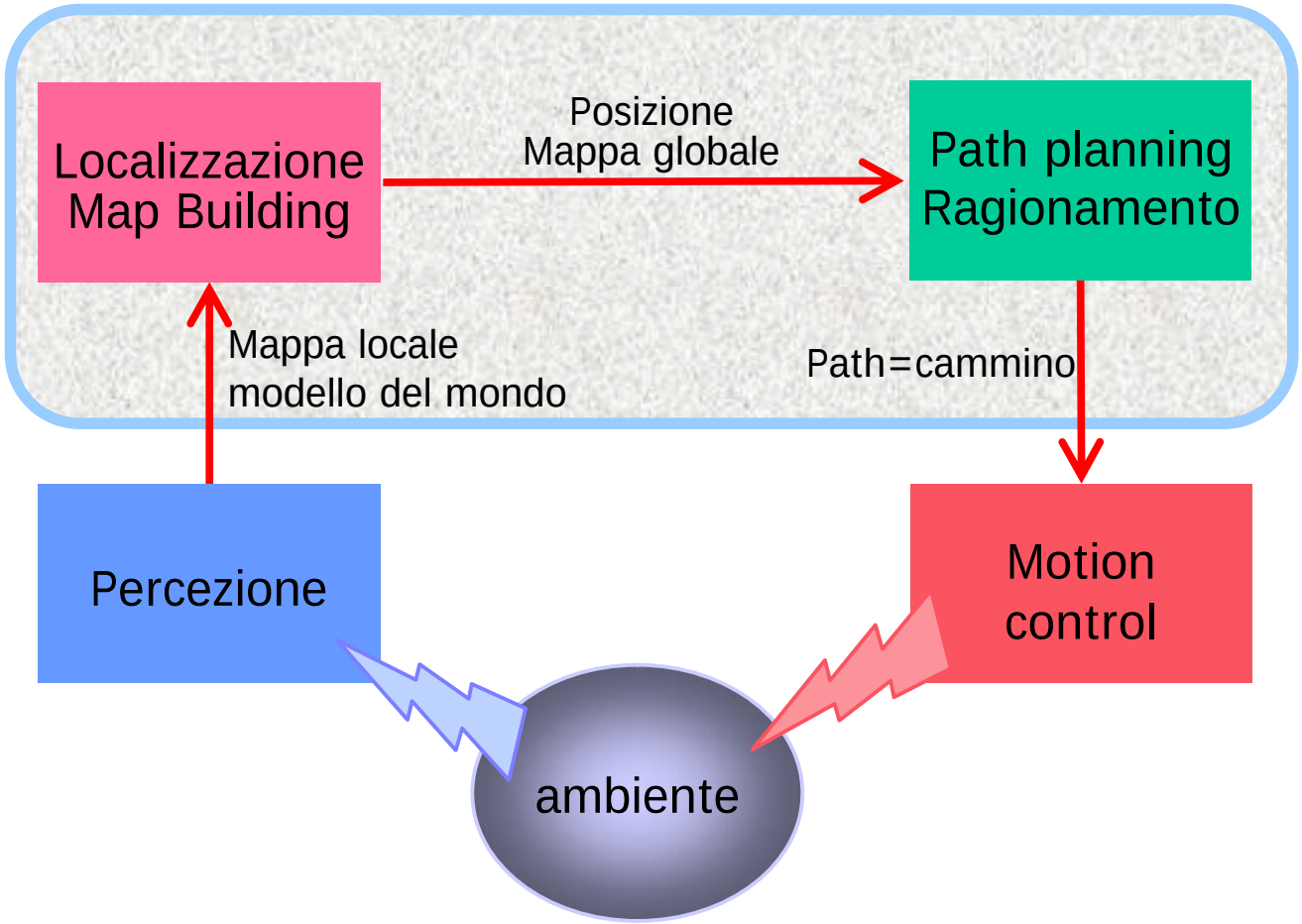
Supervisione e Controllo



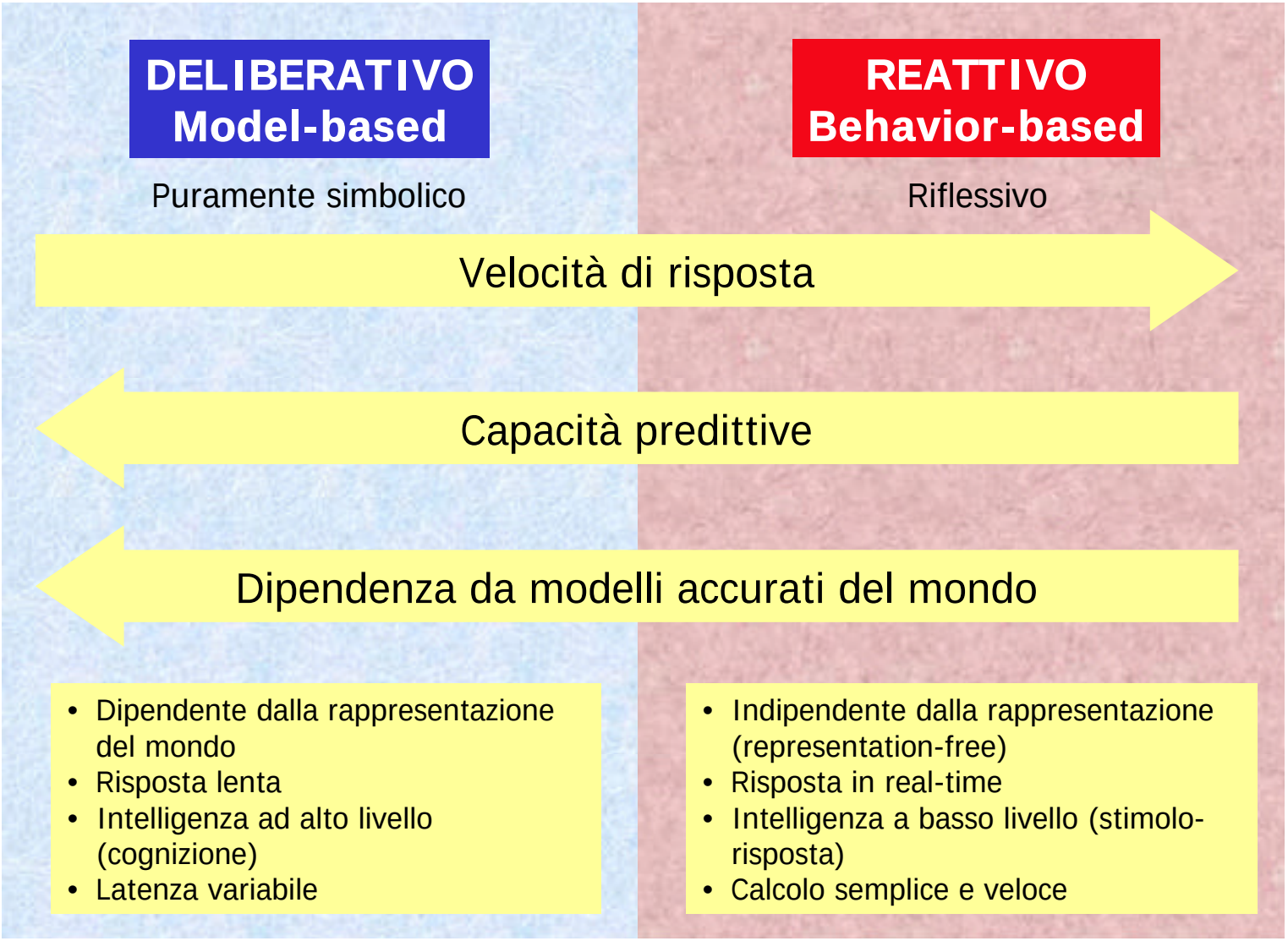
Supervisione e Controllo



Strategie di controllo

- Struttura dell'anello di controllo
  - L'ambiente o "mondo" si modifica dinamicamente
  - Non esiste un modello "compatto"
  - Vi sono molte sorgenti di incertezza
- Due approcci possibili
  - Approccio AI "classico"
    - Modellazione completa (model-based)
    - Basato su funzioni
    - Decomposizione orizzontale
  - Approccio AI "moderno"
    - Nessun modello o quasi: basato su comportamenti (behavior-based)
    - Decomposizione verticale
    - Bottom-up

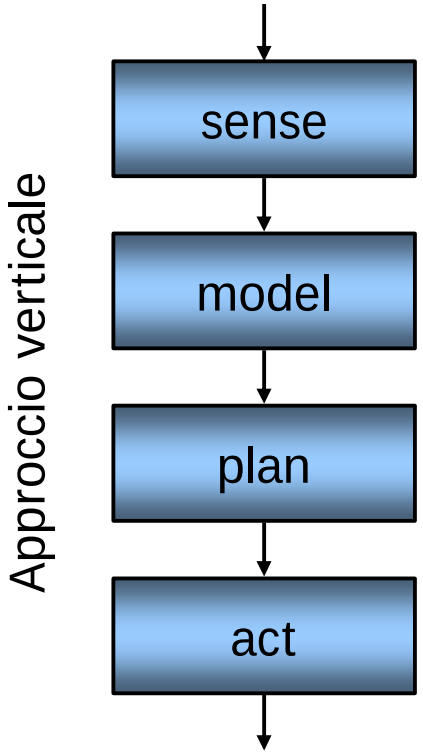
Spettro del controllo



Behavior-Based Architectures

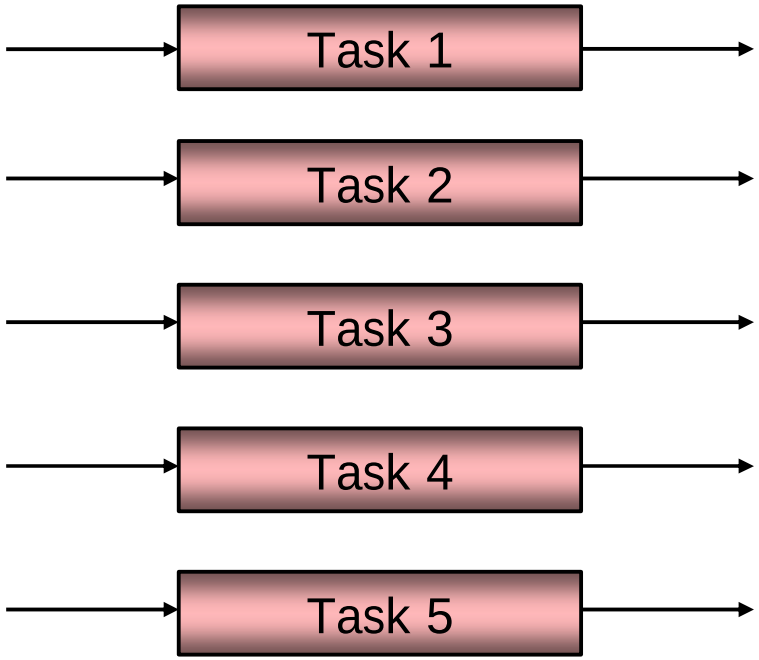
Sense – Plan – Act

Questo paradigma può impedire una risposta tempestiva ed efficace del robot



Subsumption/Reactive model

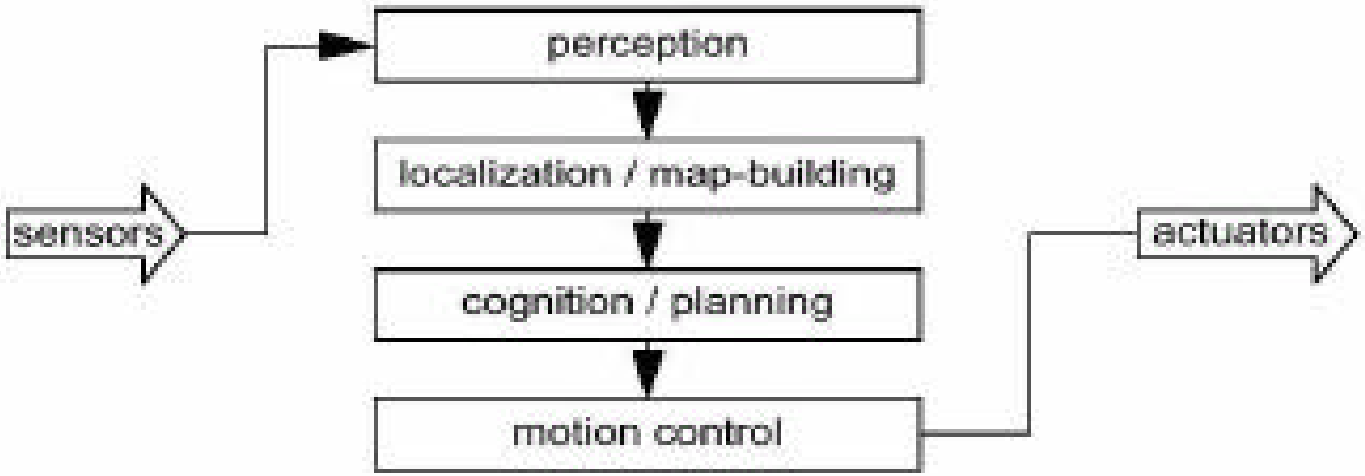
http://ai.eecs.umich.edu/cogarch0/subsump/



Approccio Model-Based

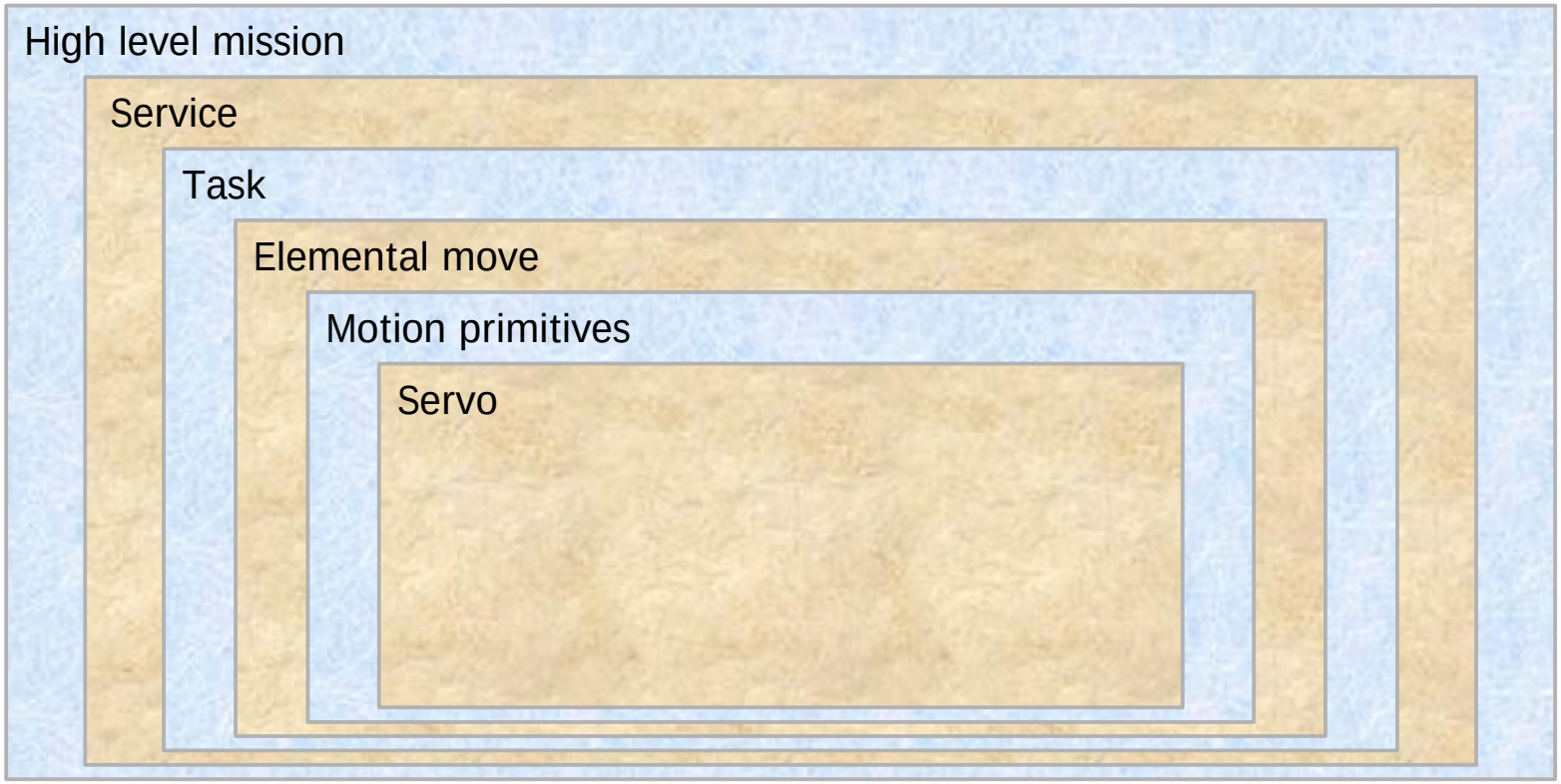
- Modellazione completa del mondo
- Ogni blocco è una funzione computata
- Decomposizione verticale dell'architettura e nested-embodiment delle funzioni:

Un primo esempio



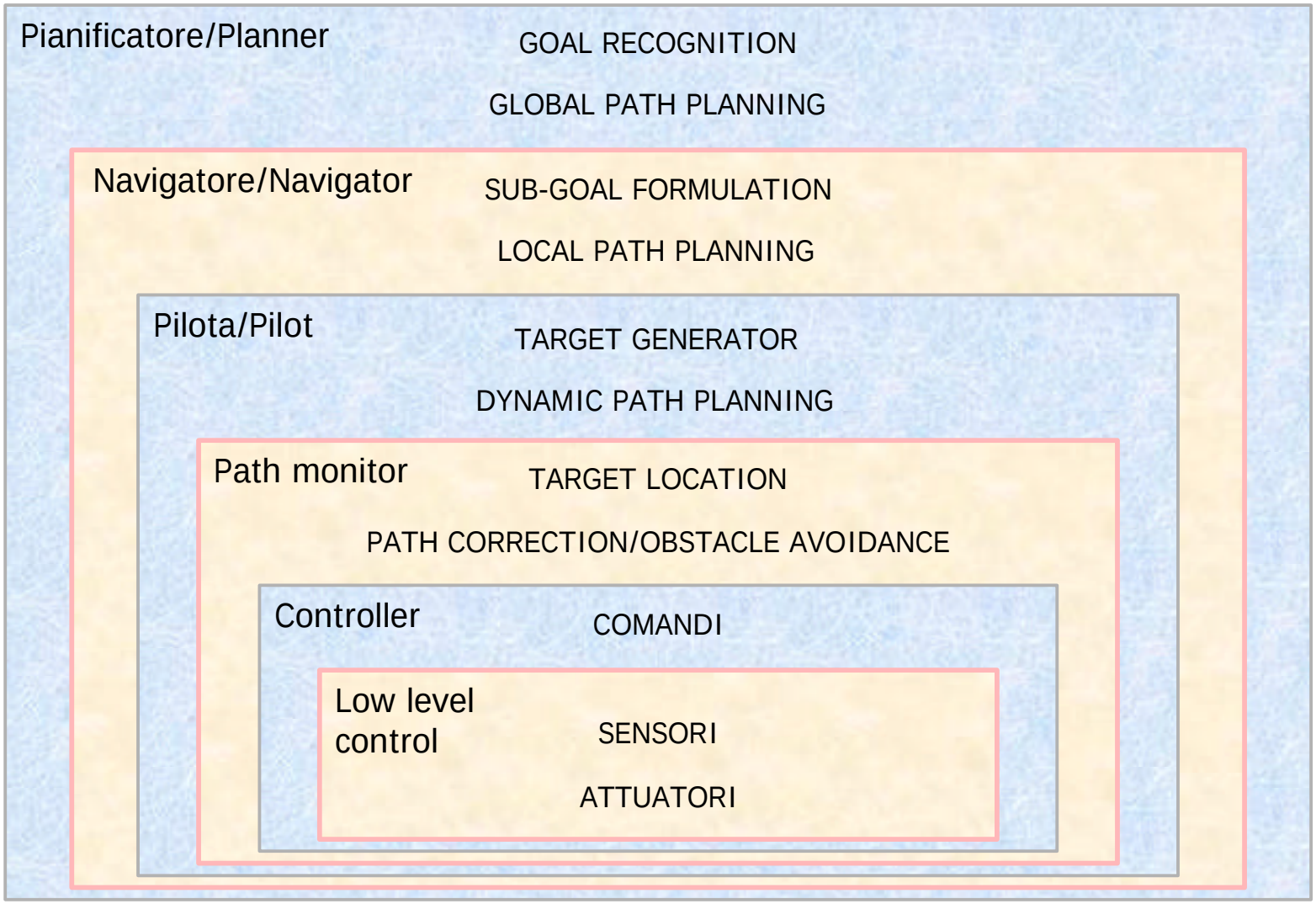
Approccio Model-Based

Un secondo esempio: nested embodiment



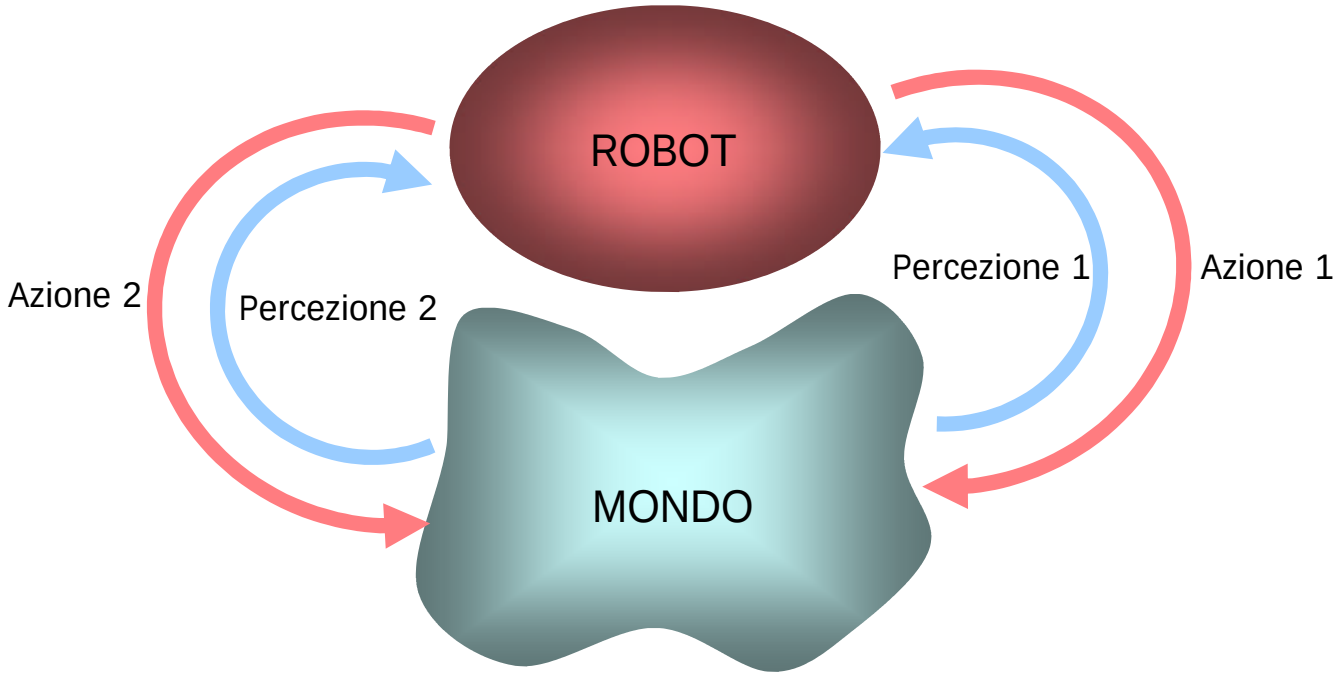
Approccio Model-Based

Un terzo esempio: nested embodiment



Approccio Behavior-Based

- Sistema “reattivi”
- Comportamento “riflessivo”
- Percezione-azione
- Subsumption



Subsumption

The subsumption architecture was originally proposed by Brooks [1986]. The subsumption (or 'Brooksian') architecture is predicated on the synergy between sensation and actuation in lower animals such as insects. Brooks argues that instead of building complex agents in simple worlds, we should follow the evolutionary path and start building simple agents in the real, complex and unpredictable world. From this argument, a number of key features of subsumption result:

- No explicit knowledge representation is used. Brooks often refers to this as "*The world is its own best model*".
- Behavior is distributed rather than centralized.
- Response to stimuli is reflexive -- the perception-action sequence is not modulated by cognitive deliberation.
- The agents are organized in a bottom-up fashion. Thus, complex behaviors are fashioned from the combination of simpler, underlying ones.
- Individual agents are inexpensive, allowing a domain to be populated by many simple agents rather than a few complex ones. These simple agents individually consume little resources (such as power) and are expendable, making the investment in each agent minimal.
- Several extensions (Mataric, 1992) have been proposed to pure reactive subsumption systems. These extensions are known as behavior-based architectures. Capabilities of behavior-based systems include landmark detection and map building, learning to walk, collective behaviors with homogeneous agents, group learning with homogeneous agents, and heterogeneous agents.

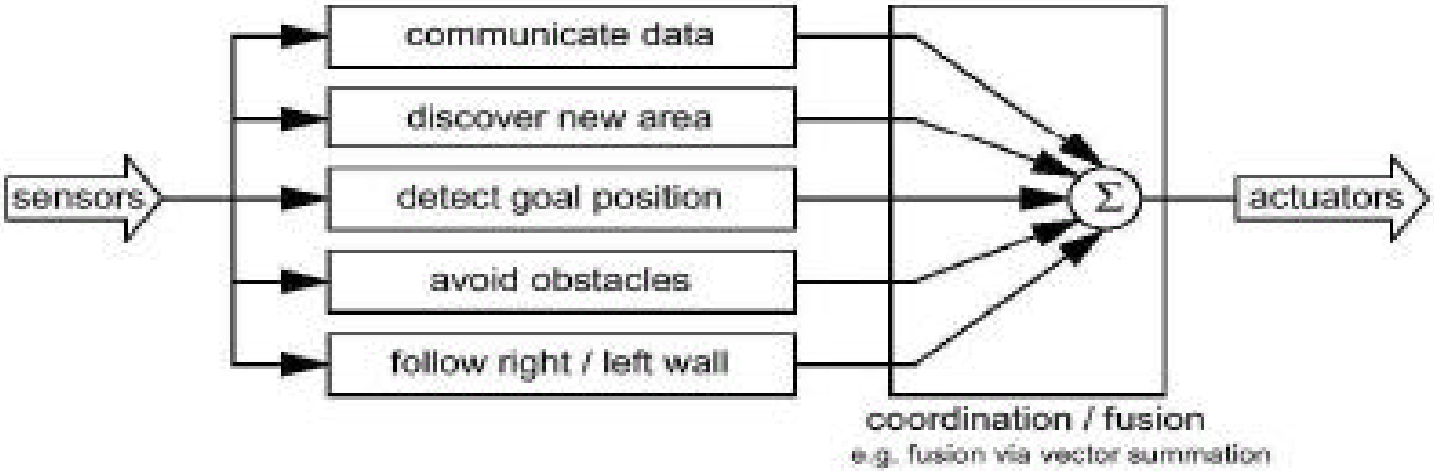
Approccio Behavior-Based

Brooks è il fondatore di questo approccio:
ecco alcune sue massime

- Complex behavior need not necessarily be the product of a complex control system
- Intelligence is in the eye of the observer
- The world is its best model
- Simplicty is a virtue
- Robots should be cheap
- Robustness in the presence of noisy or failing sensors is a design goal
- Planning is just a way of avoiding figuring out what to do next
- All onboard computation is important
- Systems should be built incrementally
- No representation. No calibration. No complex computers. No high band communication

Approccio Behavior-Based

- Nessun modello necessario
- Decomposizione orizzontale
- Coordinamento + Priorità = Fusione
- Biomimesi = osservare e copiare il comportamento animale



Robotica e AI

- Relazione tra controllori (semplici) e ambiente (complesso) viene denominato emergent behavior
- Le sette aree dell'AI per la robotica
  - Knowledge representation
  - Understanding natural languages
  - Learning
  - Planning and problem solving
  - Inference
  - Search
  - Vision

R.R. Murphy, Introduction to AI Robotics, MIT Press, 2000.

Knowledge representation

- Definire e realizzare come il robot rappresenta
  - il mondo,
  - i compiti
  - sé stesso
- Esempio: un robot sta facendo una ricerca di un essere umano sotto un mucchio di detriti: come lo rappresenta?
  - Una possibilità: modello strutturale:
    - Testa ovale
    - Torso cilindrico
    - Braccia cilindriche ma più piccole
    - Simmetria bilaterale
  - Ma cosa succede se solo una porzione dell'essere umano è visibile?

Understanding natural languages

Supponete di chiedere al vostro PC
“formatta il mio report come vuole il professore”
e domandatevi ora quali sono i passi necessari per portare a termine l’ordine ...

Riconoscere le parole NON significa comprendere la frase necessaria a portare a termine il compito

Semantica e struttura grammaticale. Le due frasi
We gave the monkeys the bananas because they were hungry
We gave the monkeys the bananas because they were over-ripe
Hanno la stessa struttura grammaticale, ma sono profondamente differenti. Per capirle bisogna conoscere sia le scimmie sia le banane

Some examples of the problems faced by natural language understanding systems: The sentences *We gave the monkeys the bananas because they were hungry* and *We gave the monkeys the bananas because they were over-ripe* have the same surface grammatical structure. However, in one of them the word *they* refers to the monkeys, in the other it refers to the bananas: the sentence cannot be understood properly without knowledge of the properties and behaviour of monkeys and bananas.

A string of words may be interpreted in myriad ways. For example, the string *Time flies like an arrow* may be interpreted in a variety of ways:

time moves quickly just like an arrow does;

measure the speed of flying insects like you would measure that of an arrow - i.e. *(You should) time flies like you would an arrow.*;

measure the speed of flying insects like an arrow would - i.e. *Time flies in the same way that an arrow would (time them).*;

measure the speed of flying insects that are like arrows - i.e. *Time those flies that are like arrows*;

a type of flying insect, "time-flies," enjoy arrows (compare *Fruit flies like a banana*.)

The word "time" alone can be interpreted as three different parts of speech, (noun in the first example, verb in 2, 3, 4, and adjective in 5).

English is particularly challenging in this regard because it has little inflectional morphology to distinguish between parts of speech.

Learning

- La capacità di memorizzare modelli , comportamenti e task guardando le azioni di altri

Planning and problem solving

- L'intelligenza è associata all'abilità si pianificare le azioni necessarie a portare a termine un compito e di risolvere i problemi che nascono quando i piani non funzionano

Inference

- L'inferenza aiuta a generare una risposta quando si hanno informazioni incomplete

Search

- Non significa necessariamente la ricerca di oggetti nello spazio fisico, bensì la capacità di esaminare una knowledge representation (chiamata search space) per trovare la risposta desiderata
- Considerate un computer che gioca a scacchi: la mossa migliore viene cercata e trovata analizzando il search space di tutte le possibili mosse a partire dalla stato presente dei pezzi sulla scacchiera

Vision

- La visione è il senso più importante dell'essere umano
- Studi psicologici suggeriscono che l'abilità di risolvere problemi dipende dalla capacità di visualizzare gli effetti delle azioni nel nostro cervello

Alcuni libri importanti

- R.C. Arkin, *Behavior-Based Robotics*, MIT Press, 1998
- R.R. Murphy, *Introduction to AI Robotics*, MIT Press, 2000
- G. Dudek, M. Jenkin, *Computational Principles of Mobile Robotics*, Cambridge U.P., 2000
- R. Siegwart, I.R. Nourbakhsh, *Autonomous Mobile Robots*, MIT Press, 2004
- Autori Vari, *Principles of Robot Motion*, MIT Press, 2005