

# Behavior Based Systems

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## Intelligent Systems... Robots

- Robotics is the intelligent connection of perception to action.
- A robot is a re-programmable, multi-functional, manipulator designed to move material, parts, tools, or specialized devices through variable programmed motions for the performance of a variety of tasks.

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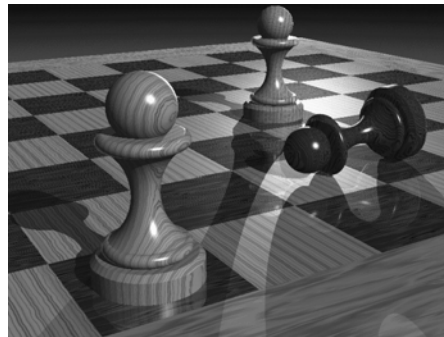


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## Symbolic AI Methods

- Knowledge Representation (Abstraction)
- Search
- Logic and Deduction
- Planning
- *But what about Real Life systems?!*



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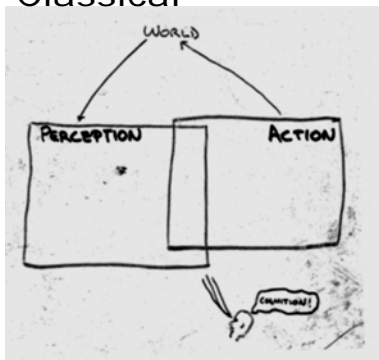


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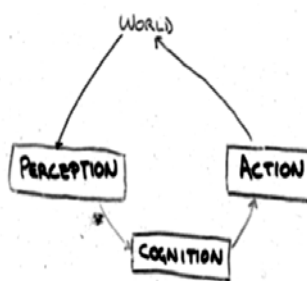
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# Design Strategy in AI

## Classical



## Brooksian



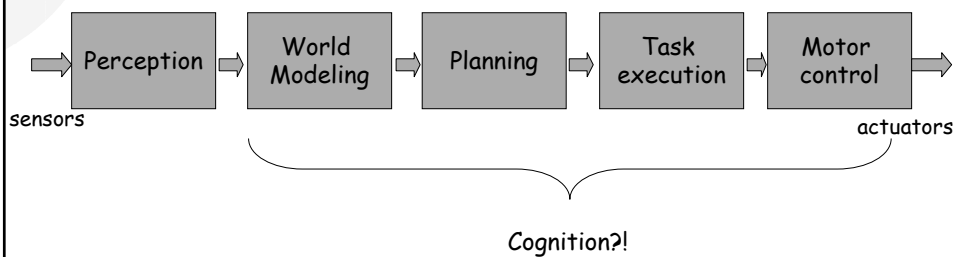
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# Symbolic AI Approach



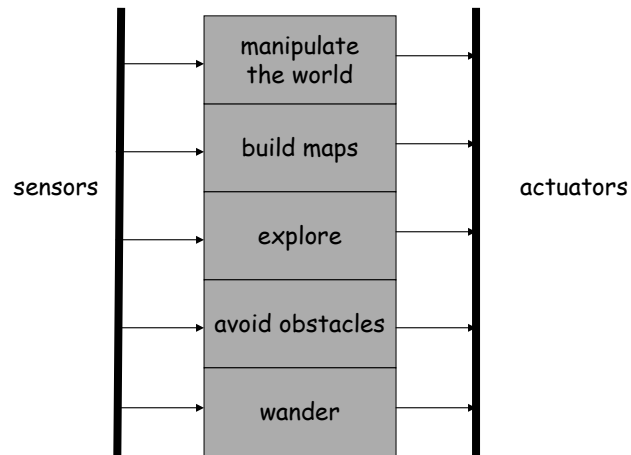
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# Behavior Decomposition



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# Achievements BBS



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## BBS Advantages

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- Robustness
- Simple Design
- Scalability
- Multiple Goals
- Multiple Sensors
- Reactiveness

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## Eye of the Beholder

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- *"...belief is all in the mind of an outside beholder" – Brooks*
- *"Intelligence without Representations"*
- *Cognition is in the Perception of the Observer*
- *No Need for World Model: "The world is its own best model"*

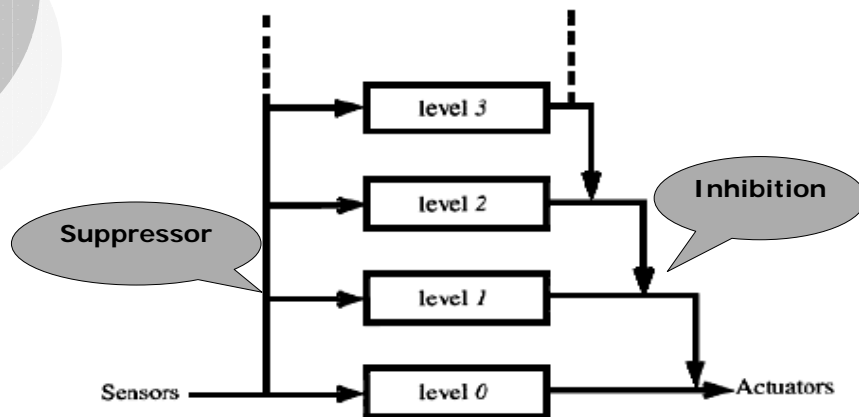
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## Subsumption Architecture



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## Applications of BBS

- Humanoid Robots
- Mobile Robots
- Real Life Robots
- Mars Rover
- Military application
- Manipulators (Recently!!)
- Factory Automation
- Hybrid Architectures

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## Learning in BBS

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- Building efficient Behaviors
- Behavior Arbitration
  - How to select the best behaviors
- Behaviors Coordination
  - Act in harmony
- Credit Assignment
  - Who is who?!
- Behavior Hierarchy
  - How to Inhibit or Suppress?!

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## Learning Tools

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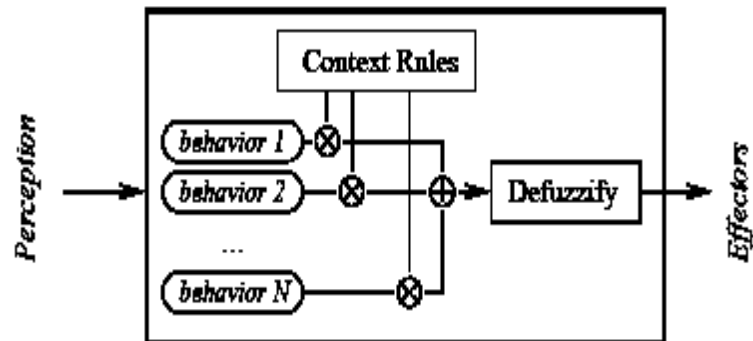
- Artificial Neural Nets
- Reinforcement Learning
  - Learning from experience
- Evolutionary Learning
- Learning by Imitation

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## Behavior Coordination and Arbitration



[Saffiotti-94]

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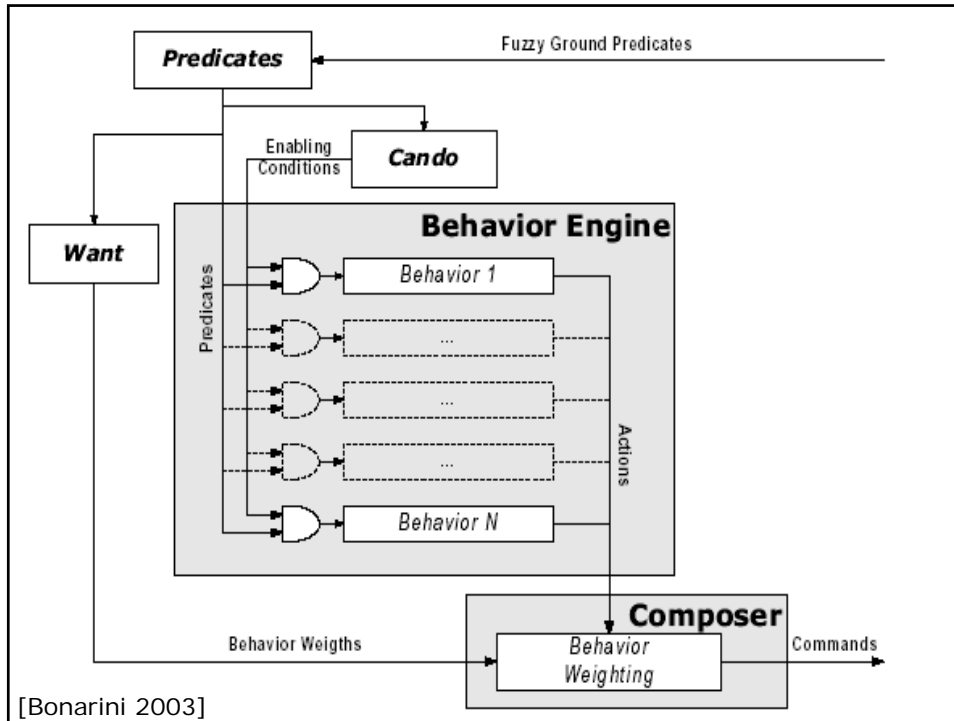
## Fuzzy Behavior Coordination

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## Multi Agents and BBS

- Intelligence as result of interaction with environment and other agents
- BBS is suitable for Multi-agent systems
- Simple rules by many robust produce complex cooperative behavior → Emergence

## An Eye on Context Based Systems

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- Behavior Coordination and Arbitration Creates Situation Aware Systems
- The key idea of Creating Dynamic Context is Genesis of new behaviours
- Parallel Nature of BBS is Suitable for Producing Emergence
- Considering a system to be Context aware is depends on the Observer

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## Summary

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- Symbolic AI Condemnation
- Brief Look at Behavior Based
- Subsumption Architecture
- Learning in BBS
- Adaptation in BBS
- Multi agents and BBS

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