



Universität Bremen

# Kognitive Architekturen

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Überblick

Theorien

Architekturen

Multiagenten

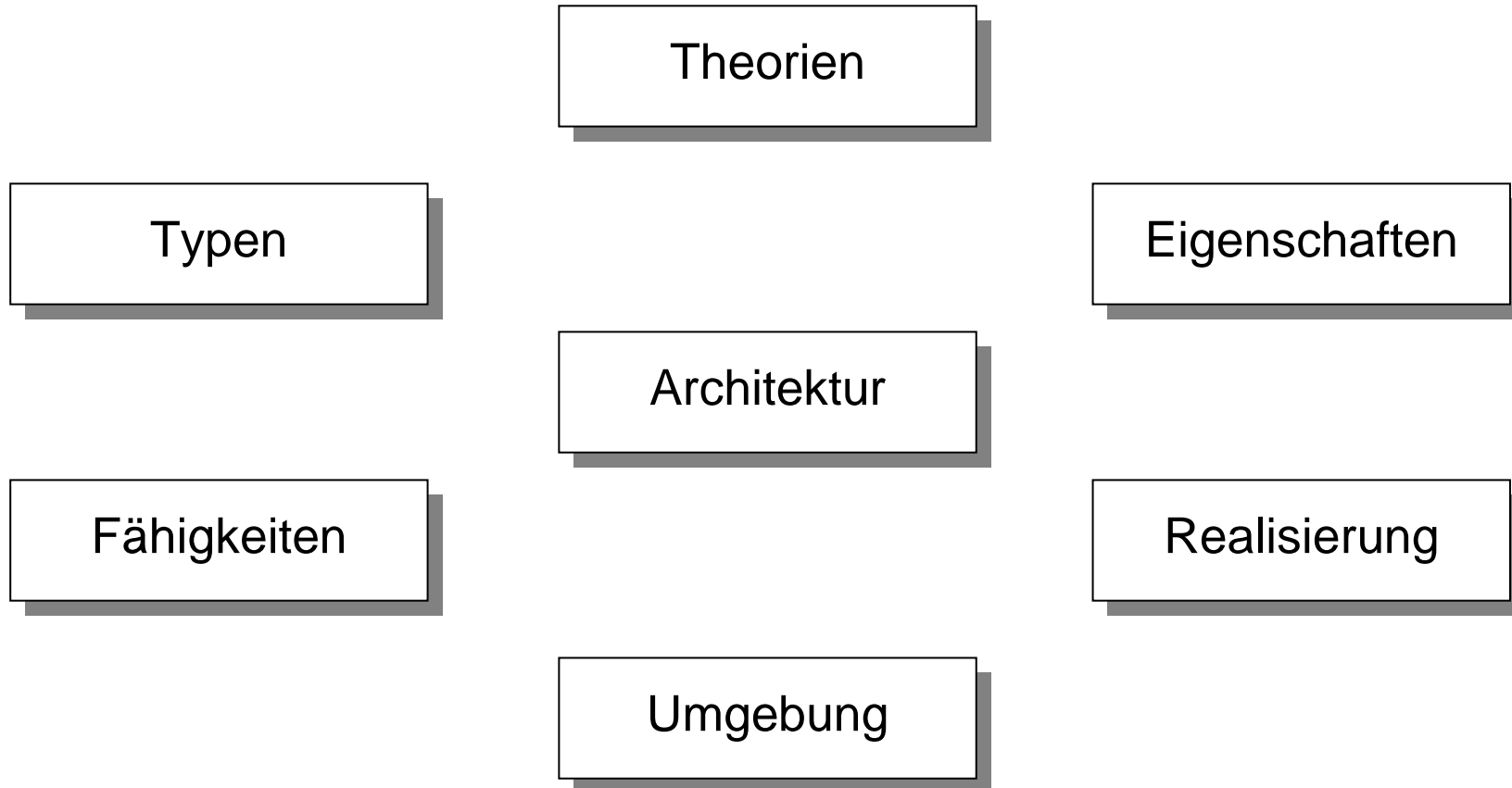


# Kognitive Architekturen

- ▶ **ko|gni|tiv** «Adj.» (bes. Psych., Päd.): *das Wahrnehmen, Denken, Erkennen betreffend; erkenntnismäßig: -e Fähigkeiten.*
- ▶ **Ar|chi|tek|tur**, die; -, -en [lat. architectura]:
  1. «o. Pl.» *Baukunst [als wissenschaftliche Disziplin]: A. studieren; Zeugnisse der maurischen A.; Ü geistige A. (bildungsspr.; Kunst des strengen geistigen Aufbaus).*
  2. *[mehr od. weniger] kunstgerechter Aufbau u. künstlerische Gestaltung von Bauwerken: die kühne, gotische A. eines Bauwerks; Ü die A. eines Musikstücks, [Kunst]werkes.*
- ▶ An architecture can be defined simply as the portion of a system that provides and manages the primitive resources of an agent. For many cognitive architectures, these resources define the substrate upon which a physical symbol system is realized (<http://ai.eecs.umich.edu/cogarch0>).



# Überblick





## Theorien – Pylyshyn

- ▶ **Architecture-relativity of algorithms and strong equivalence**
  - ▶ We can design an algorithm that corresponds to a specific cognitive process only when we have first made relevant assumptions about the architecture.
- ▶ **Architecture as a theory of cognitive capacity**
  - ▶ The architecture provides cognitive constants (namely, capacity), while the algorithms provide parameters decreed by the information coming in.
- ▶ **Architecture as marking the boundary of representation-governed processes**
  - ▶ A general assumption in cognitive science is that there is a domain of mental phenomena that can be explained in terms of representations and functions that operate over those representations



## Theorien – Newell

- ▶ **Intelligence**
  - ▶ is the degree to which a system approximates a knowledge-level system
- ▶ **Knowledge-Level System**
  - ▶ rationally brings to bear all its knowledge onto every problem it attempts to solve
- ▶ **Maximum Rationality Hypothesis**
  - ▶ If an agent has knowledge that one of its actions will lead to one of its goals, then the agent will select that action



## Theorien – Anderson

### ▶ **Optimal Rationality**

- ▶ The cognitive system optimizes the adaptation of the behavior of the organism

### ▶ **Rational Analysis**

- ▶ Precisely specify the goals of the agent.
- ▶ Develop a formal model of the environment to which the agent is adapted.
- ▶ Make the minimal assumptions about computational costs.
- ▶ Derive the optimal behavior of the agent considering the three points above.
- ▶ Examine the literature to see if the behaviors of the agent reproduce empirical human data.
- ▶ If predictions are off, iterate.



## Theorien – Simon

### ▶ **Bounded Rationality**

- ▶ that property of an agent that behaves in a manner that is nearly optimal with respect to its goals as its resources will allow.

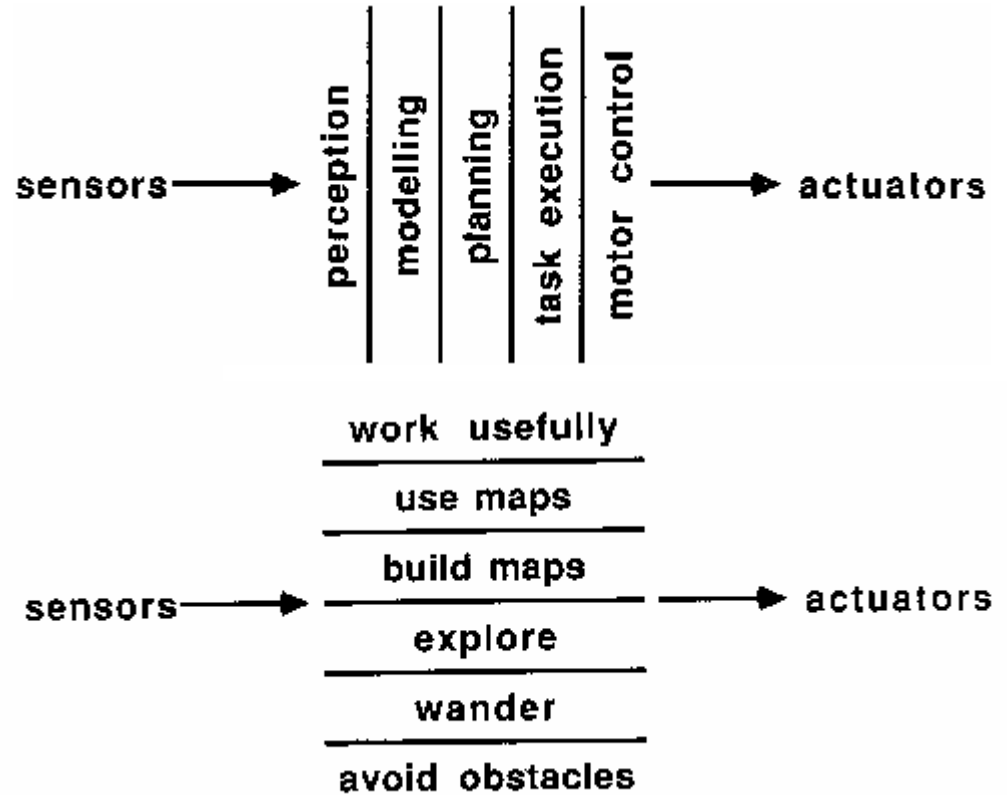
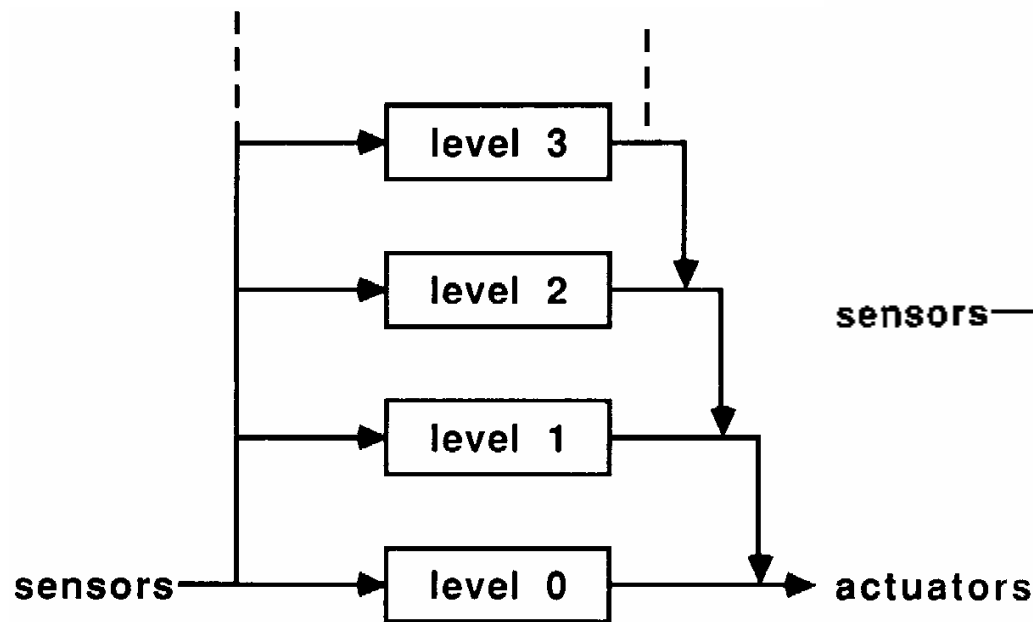
### ▶ **Differences from Anderson**

- ▶ agents are not optimal
- ▶ the methods by which architectural tasks are performed significantly affect the agents behaviors
- ▶ the representations of information and the strategies for solving problems must all be discovered by the agent
- ▶ agents' behaviors across isomorphic task domains are not constant

# Architekturen – Subsumption

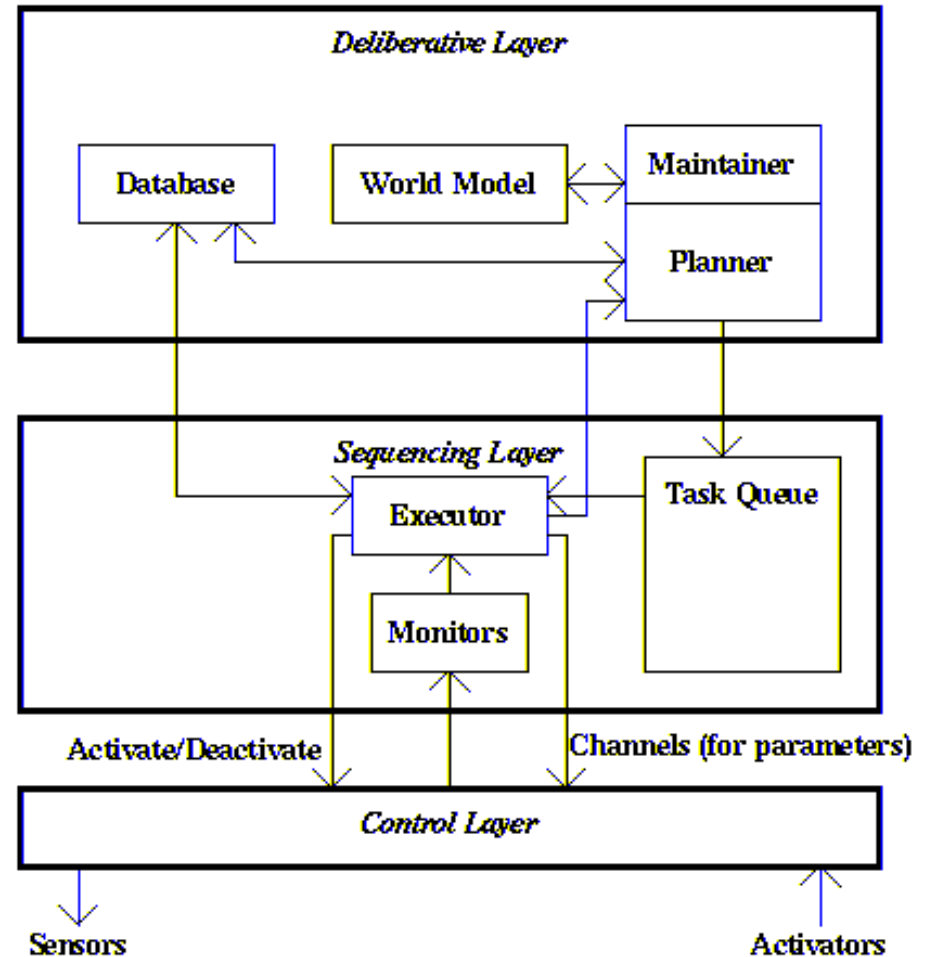
▶ **Ansatz**

- ▶ Verhaltensorientiert
- ▶ Parallel
- ▶ Hierarchisch



# Architekturen – ATLANTIS

- ▶ **Bedeutung**
  - ▶ A Three-Layer Architecture for Navigating Through Intricate Situations
- ▶ **Steuerungsstufe**
  - ▶ Auslesen der Sensoren
  - ▶ Reaktive Steuerung der Motoren
  - ▶ Art der sensomotorischen Kopplung (Aktion) wird von Sequenzierungsstufe vorgegeben
- ▶ **Sequenzierungsstufe**
  - ▶ Höhere Sicht der Roboteraktionen
  - ▶ Starten und Stoppen von Aktionen
- ▶ **Deliberative Stufe**
  - ▶ Reagiert auf Anforderungen der Sequenzierungsstufe und führt Planungen aus
  - ▶ Symbolisches Weltmodell



# Architekturen – Prodigy

▶ **Bedeutung**

- ▶ Talent, Wunderkind

▶ **Ansatz**

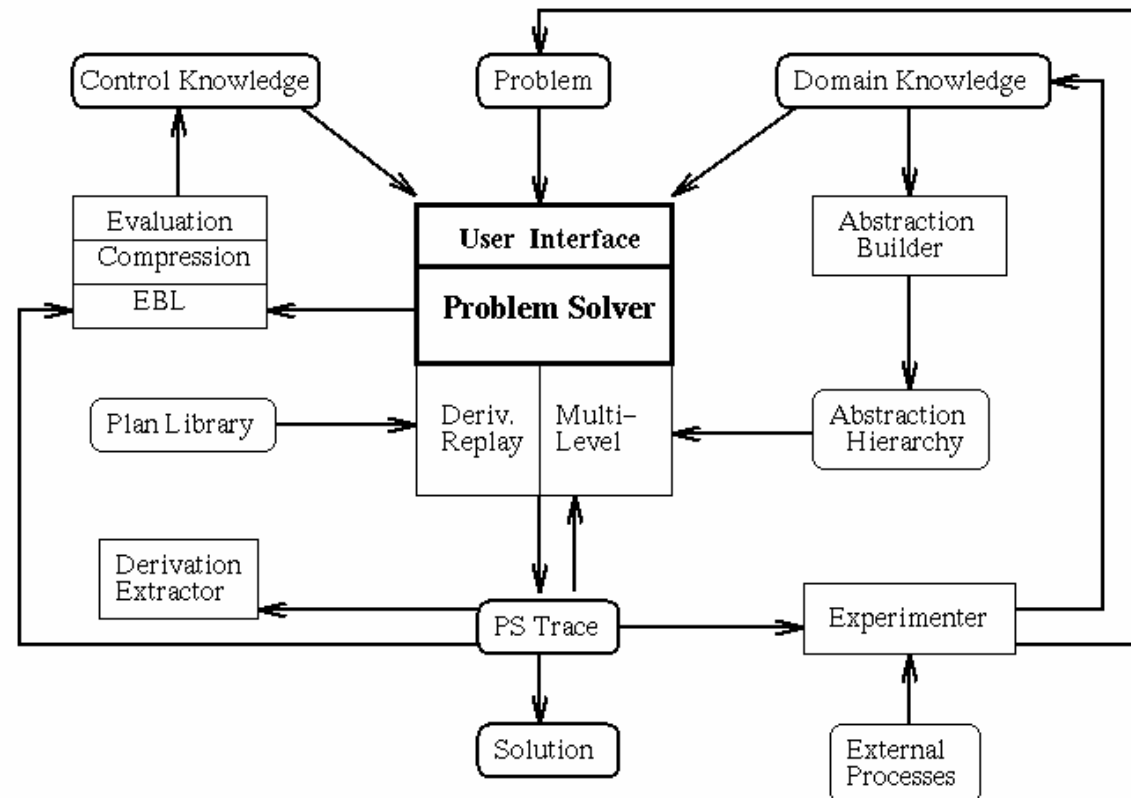
- ▶ Allgemeiner Problemlöser
- ▶ lernfähig

▶ **PDL**

- ▶ Atomare Formeln
- ▶ Operatoren: Aktion → Effekt
- ▶ Inferenzregeln
- ▶ Kontrollregeln
- ▶ Selbstreflexion

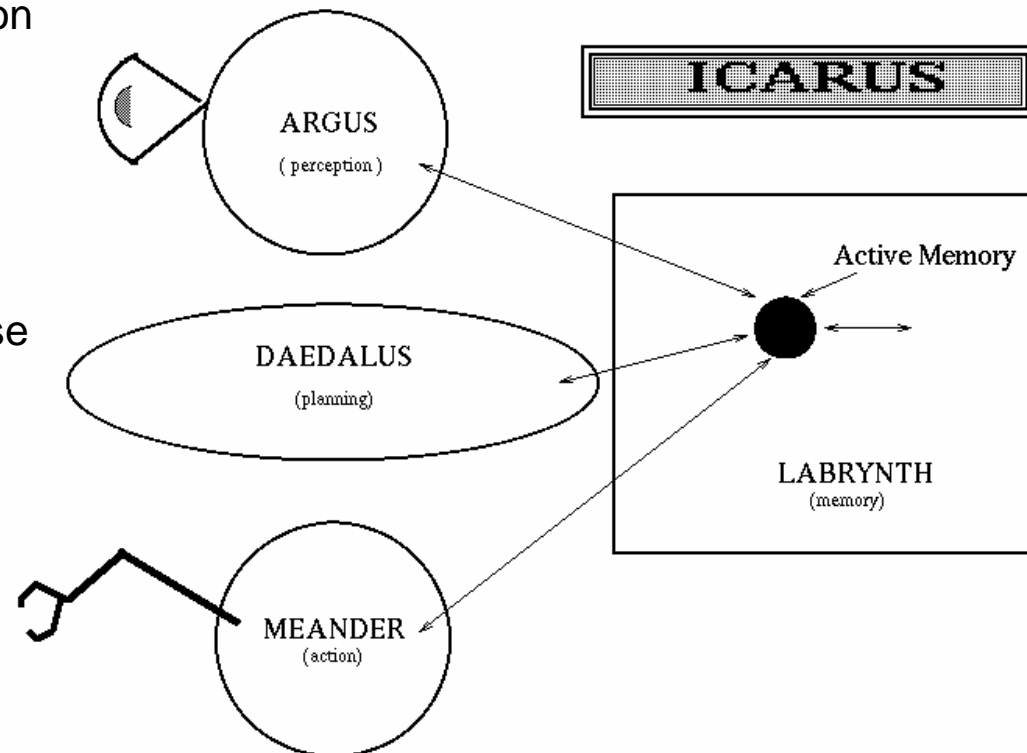
▶ **Umgebung**

- ▶ Simuliert
- ▶ Statisch



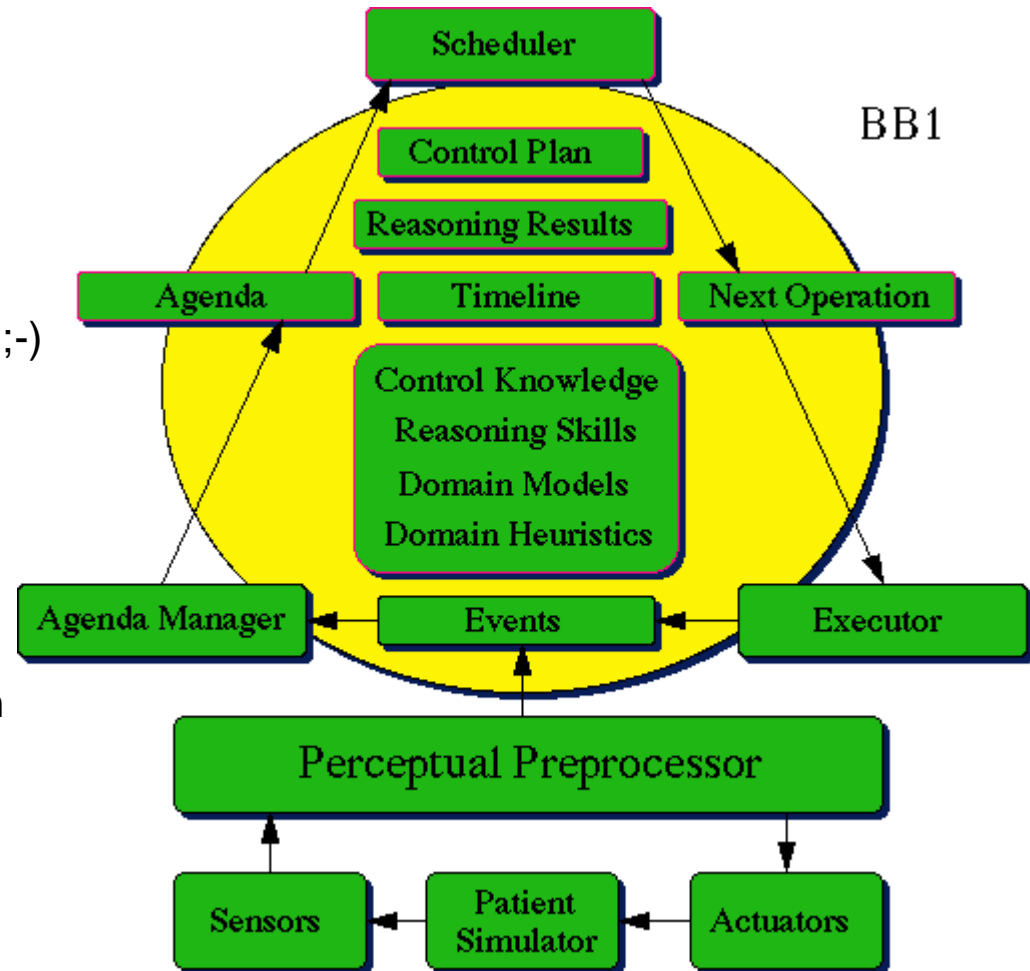
# Architekturen – ICARUS

- ▶ **Labyrinth**
  - ▶ Symbolische Wissensrepräsentation
  - ▶ Hierarchie von Konzepten
  - ▶ Blackboard
- ▶ **Deadalus**
  - ▶ Planer
  - ▶ Means-Ends (Mittel-Zweck) Analyse
- ▶ **Argus**
  - ▶ Selektive Wahrnehmung
  - ▶ Beachten des aktuellen Plans im Labyrinth
- ▶ **Meander**
  - ▶ Ausführung der Aktionen



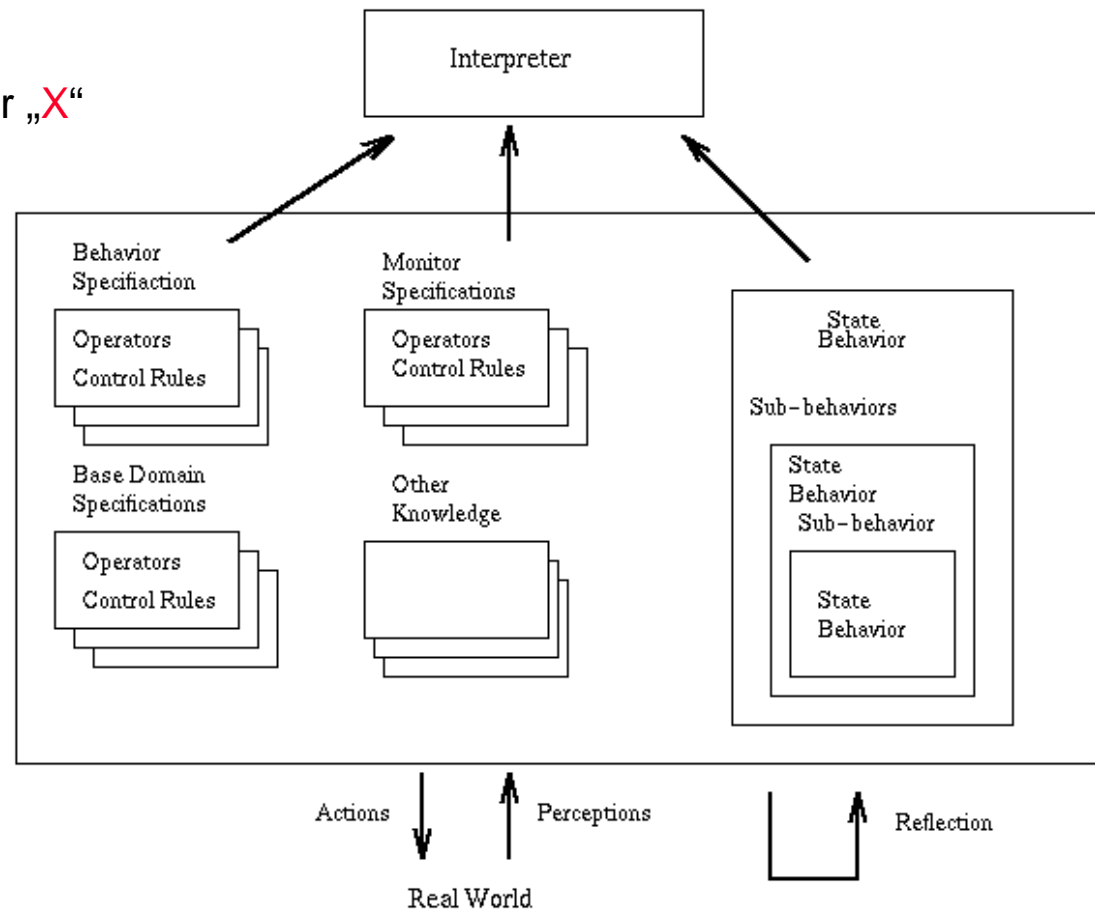
# Architekturen – AIS

- ▶ **Bedeutung**
  - ▶ Adaptive Intelligent System
- ▶ **Ansatz**
  - ▶ Sense-think-act-Zyklus
  - ▶ Realzeit-Fähigkeit durch Vergessen ;-)
- ▶ **Agenda**
  - ▶ Planung der Berechnungen in Abhängigkeit von aufgetretenen Ereignissen
- ▶ **Scheduler**
  - ▶ Auswahl der jeweils nächsten Aktion aus der Agenda
- ▶ **Executor**
  - ▶ Ausführung der nächsten Aktion



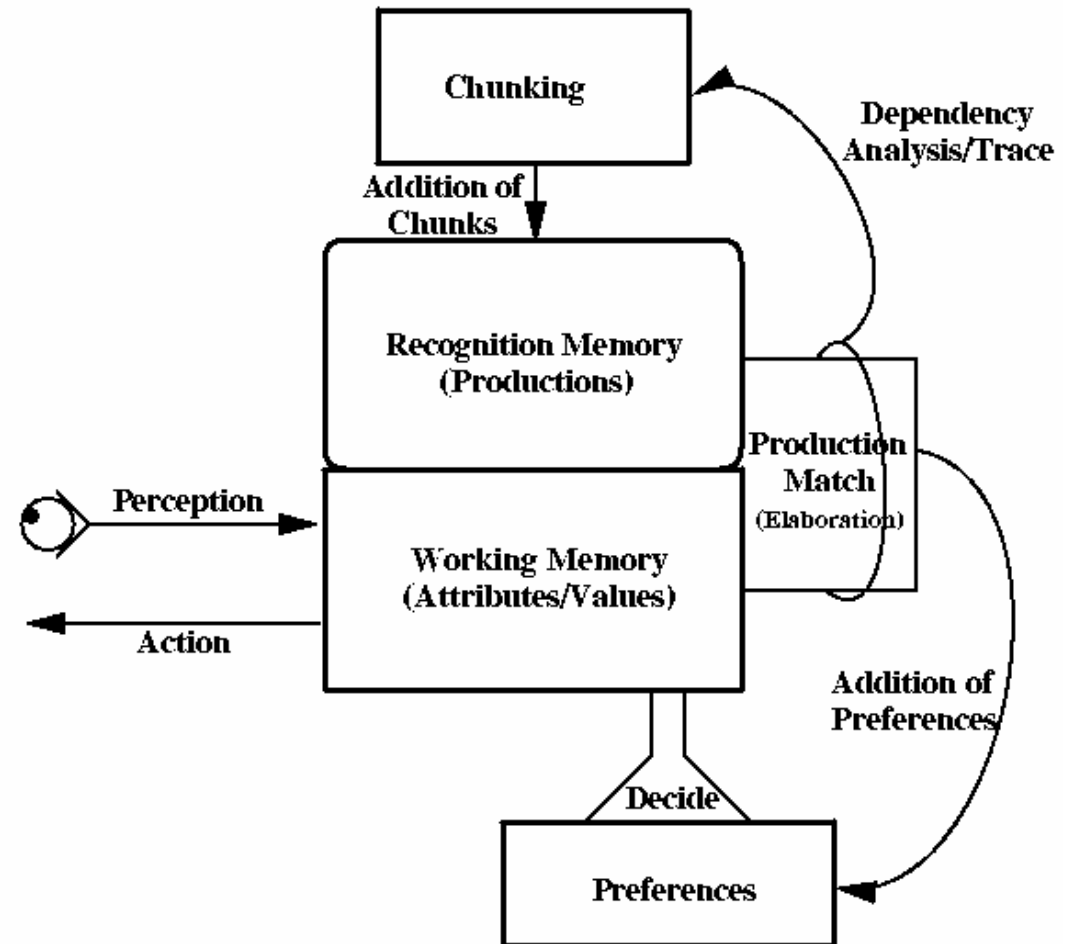
# Architekturen – MAX

- ▶ **Bedeutung**
  - ▶ Meta-Reasoning Architecture for „X“
- ▶ **Interpreter**
  - ▶ Allgemeiner Problemlöser
- ▶ **Verhalten**
  - ▶ Hierarchisch
  - ▶ Sequenziell
- ▶ **Monitore**
  - ▶ Überwachung im Hintergrund
- ▶ **Domänenwissen**
  - ▶ Spezielles Wissen
  - ▶ Erlerntes Wissen



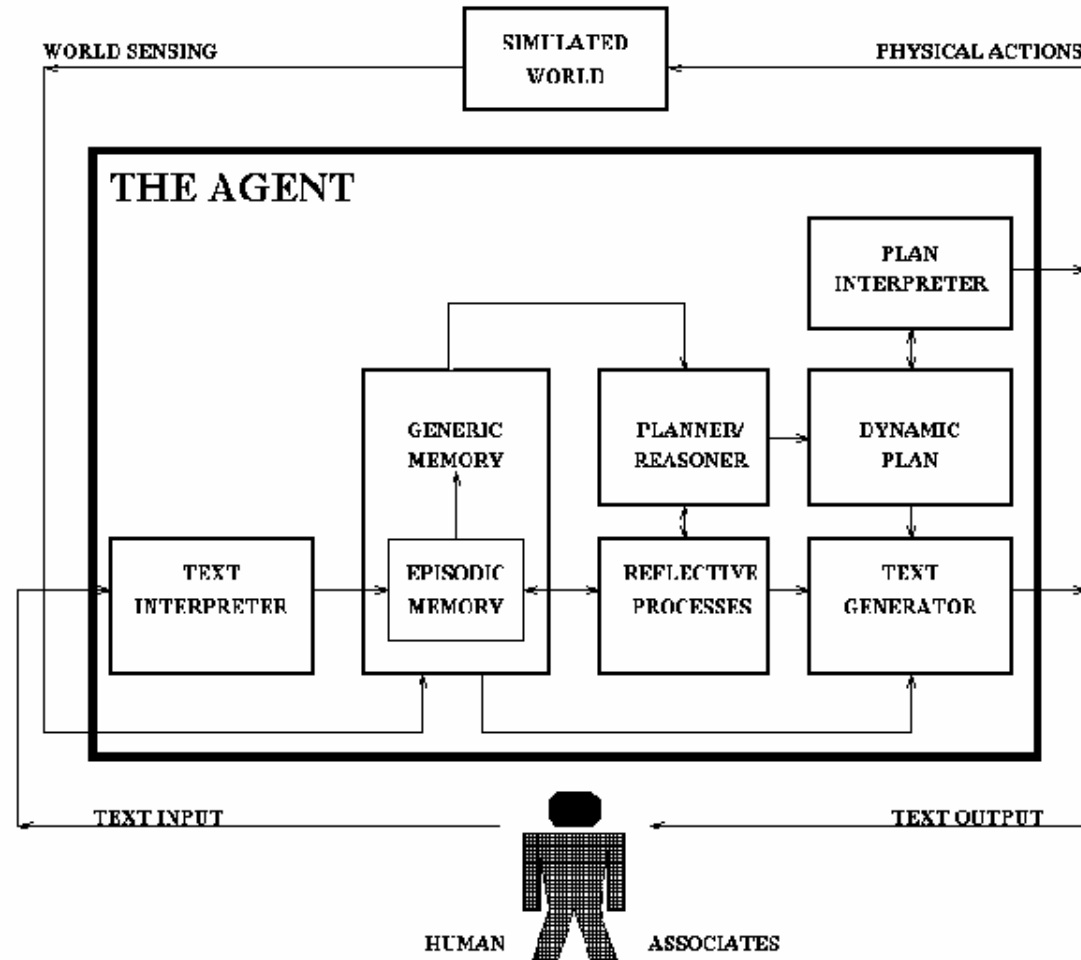
# Architekturen – SOAR

- ▶ **Bedeutung**
  - ▶ State, Operator And Result
- ▶ **Grundmechanismen**
  - ▶ Problem Spaces
  - ▶ Langzeitgedächtnis
  - ▶ Kurzzeitgedächtnis
  - ▶ Präferenzgedächtnis
  - ▶ Entscheidungsprozess
  - ▶ Sensomotorische Subsysteme
  - ▶ Zielorientiertes Verhalten
  - ▶ Lernen



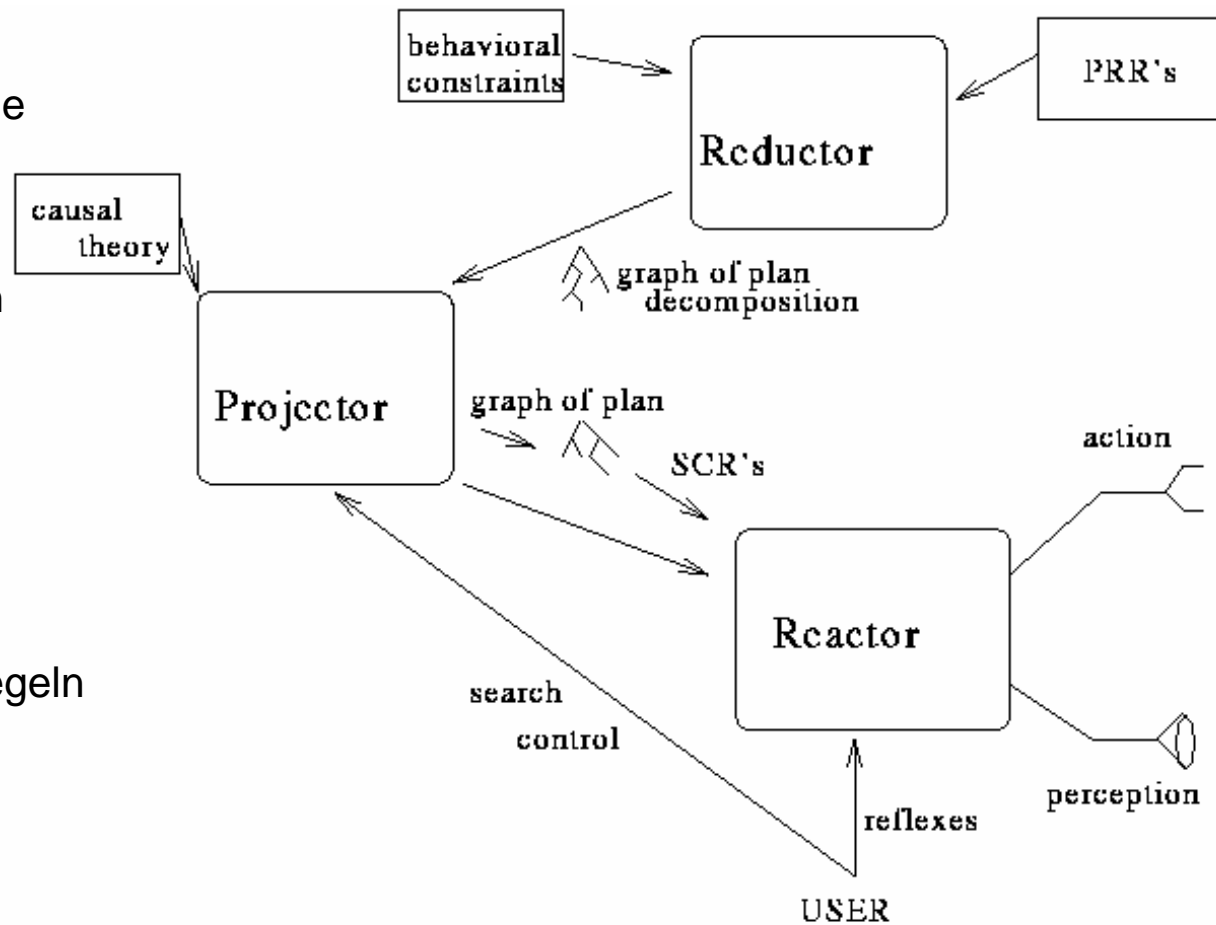
# Architekturen – Homer

- ▶ **Ziel**
  - ▶ Planung, Lernen, Verstehen natürlicher Sprache und Roboter-navigation in einem System
  - ▶ Modulare Architektur
- ▶ **Gedächtnis**
  - ▶ Allgemein
  - ▶ Episodisch
  - ▶ Reflexiv
- ▶ **Planung**
  - ▶ Planer
  - ▶ Dynamischer Plan
  - ▶ Planinterpretier
- ▶ **Sprache**
  - ▶ Lexipedia
  - ▶ Textinterpretier
  - ▶ Textgenerator

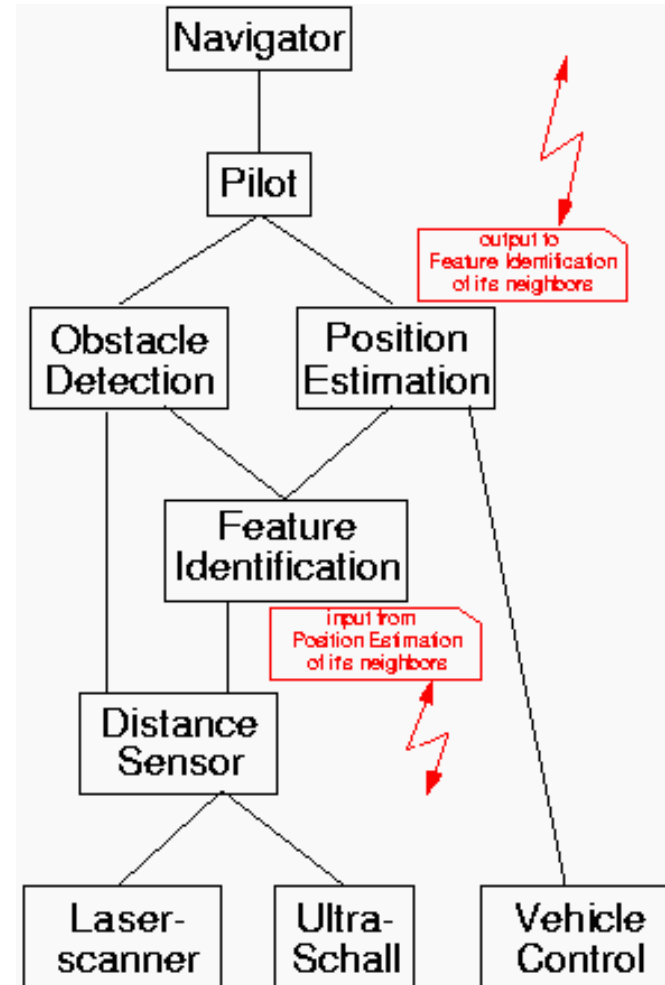


# Architekturen – ERE

- ▶ **Bedeutung**
  - ▶ Entropy Reduction Engine
- ▶ **Reductor**
  - ▶ Problemlöser
  - ▶ Problemreduktionsregeln
  - ▶ Graphrepräsentation
- ▶ **Projector**
  - ▶ Planer
  - ▶ Scheduler
- ▶ **Reactor**
  - ▶ Ausführung von Steuerregeln



# Multiagenten – Mehrere Roboter



# Multiagenten – Mehrere Komponenten

