Workshop on Artificial Intelligence in Practice

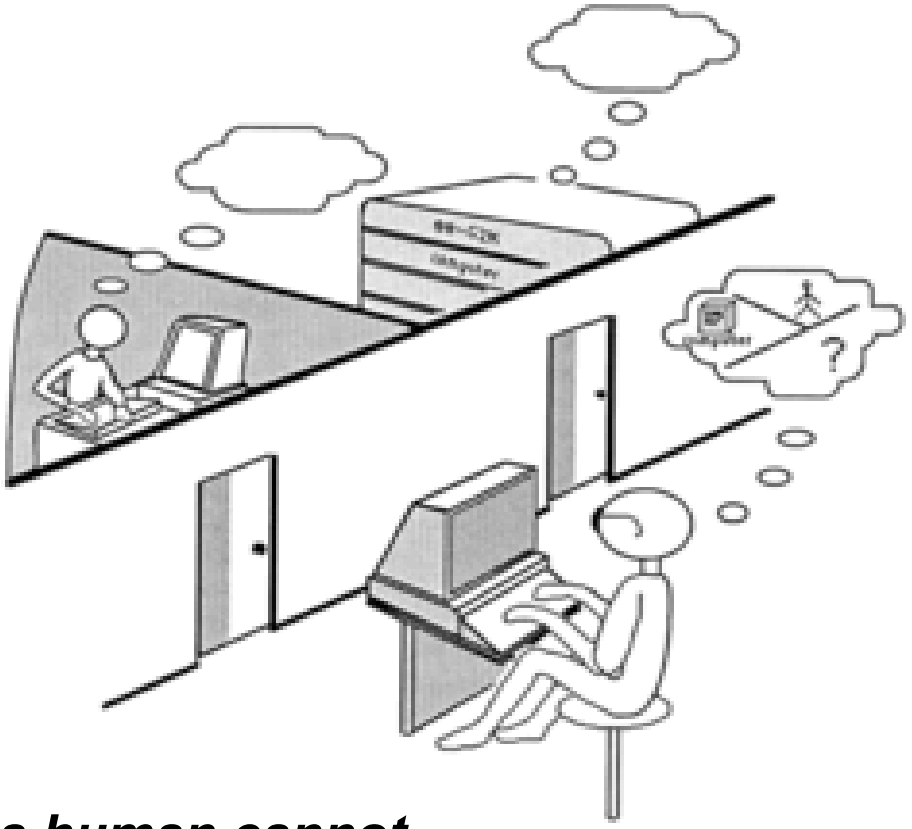
Part 1: AI Targets and Applications in Technics and Logistics

Sebastian Iwanowski
FH Wedel (D)
Erasmus Workshop at Fontys University, Eindhoven (NL)

Section 1: Survey

What is AI?

Turing‘s test



A software is intelligent when a human cannot distinguish the software‘s behaviour from another human‘s behaviour.

Application: Medical Diagnosis

Psychoanalysis: Eliza

1966: Joseph Weizenbaum, MIT

A computer conducts a psychoanalytic session and behaves such „as normally expected by a psychotherapist“.

- **passed Turing‘s test with a lot of humans**
- **featured built-in speech assember and composer**
- **worked on generic rules to react**

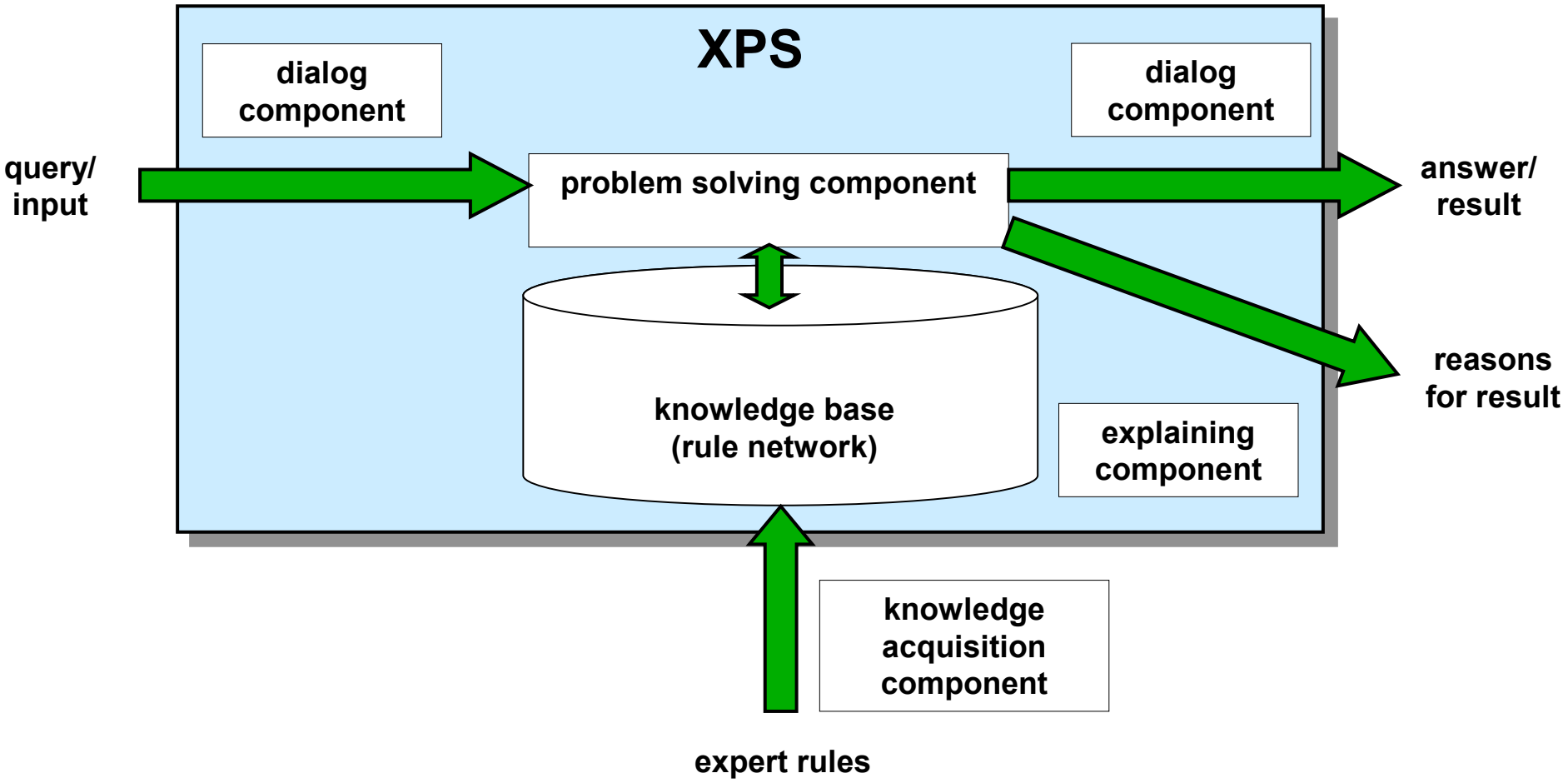
Medical Diagnosis: Mycin

1972: University of Stanford

- **for diagnosis and therapy of infectious deseases**
- **worked with probabilistic rules**
- **good results**
- **little acceptance among physicians due to general distrust in computers**

Basic Technology: Expert System

Architecture of an Expert System



Application: Technical Diagnosis

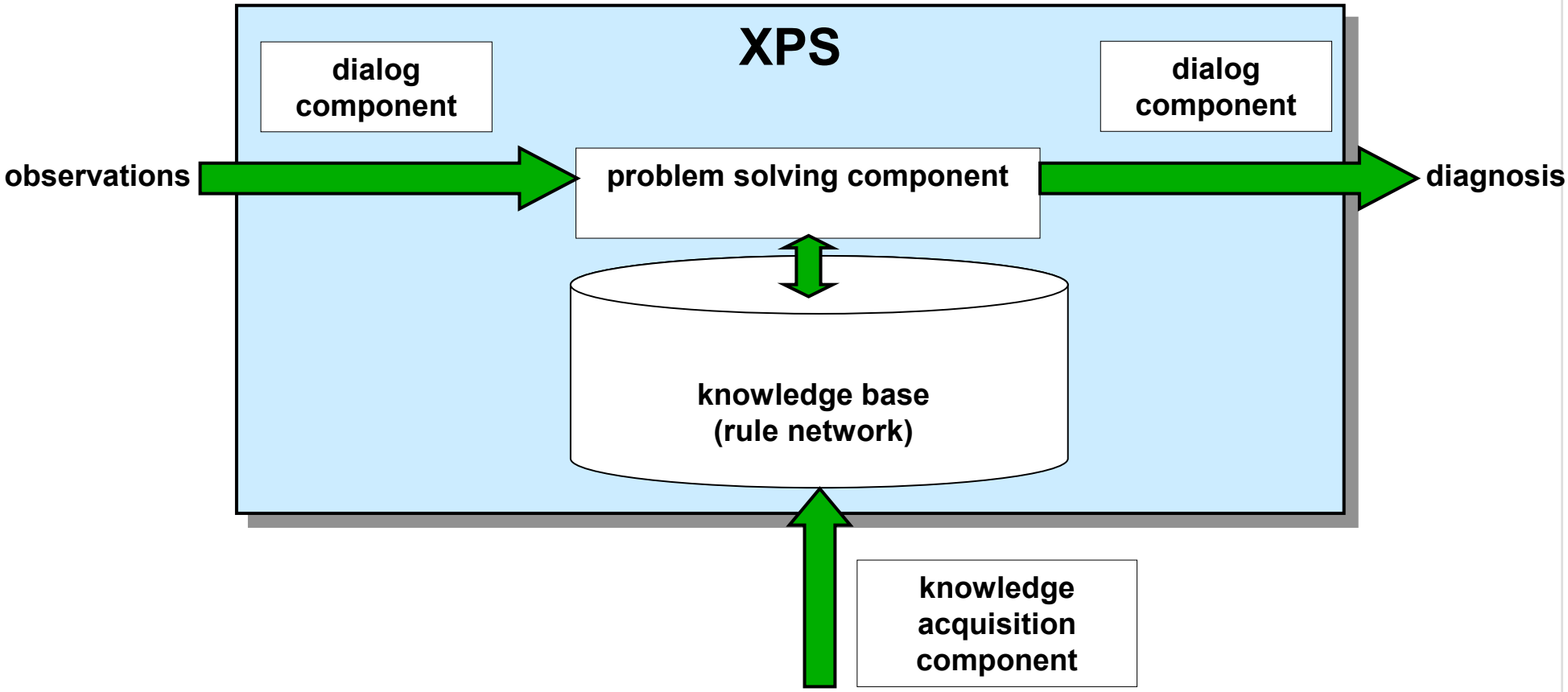
What is technical diagnosis?

Objective:
- technical system (e.g. car, train)
- observations (e.g. measured values, fault codes, customer reclaim), not normal.

Task:
Identify,
- in which way the system is faulty
- accurate enough in order to recover the normal behaviour of the system.

Application: Technical Diagnosis

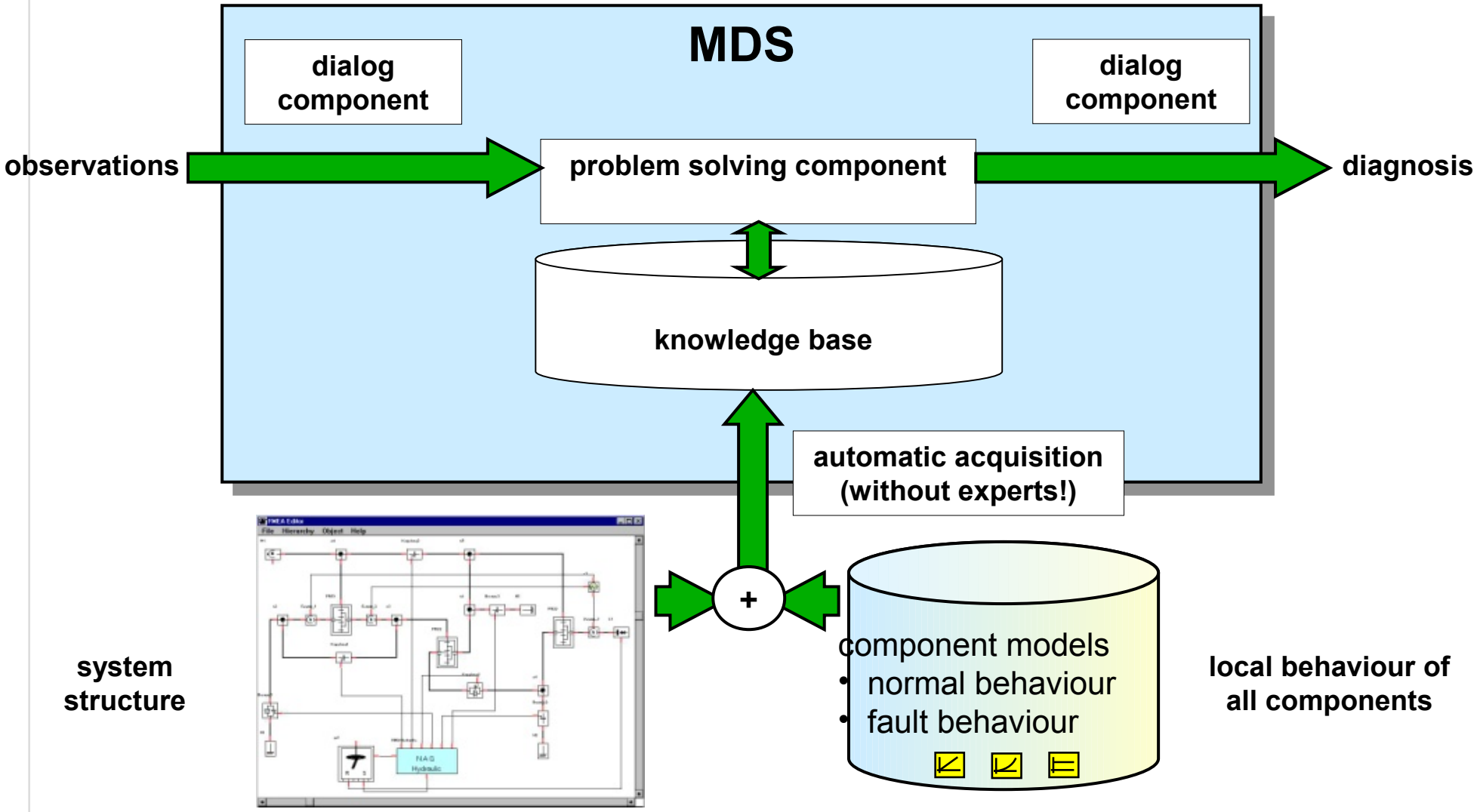
1970ies: diagnosis = heuristic classification



knowledge about function and structure:
precise symptom ⇒ precise diagnosis

Anwendung: Technische Diagnose

1980ies: diagnosis = model-based reasoning

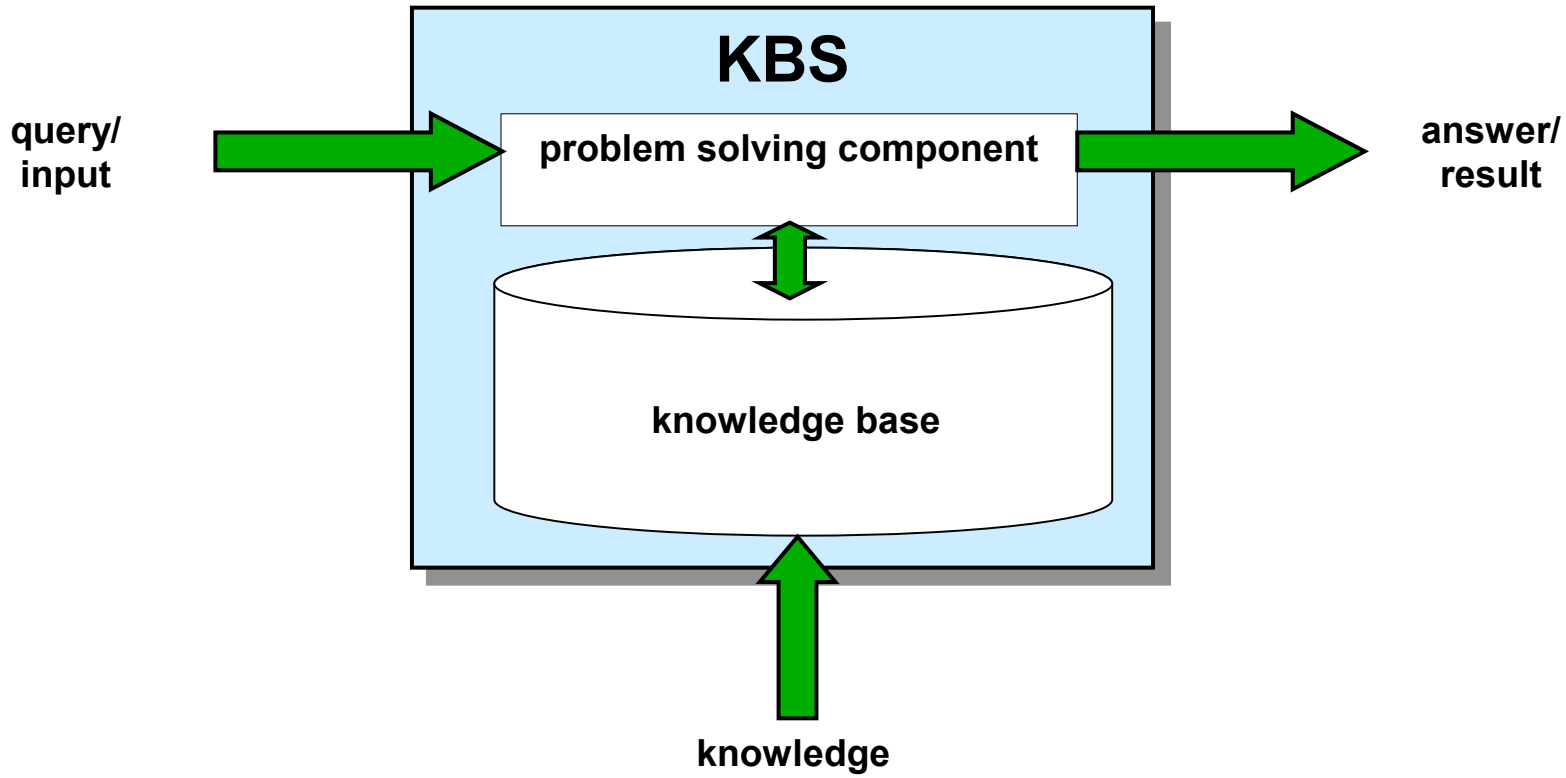


Basic Technology: Knowedge-Based System

knowledge + problem solving component = KBS

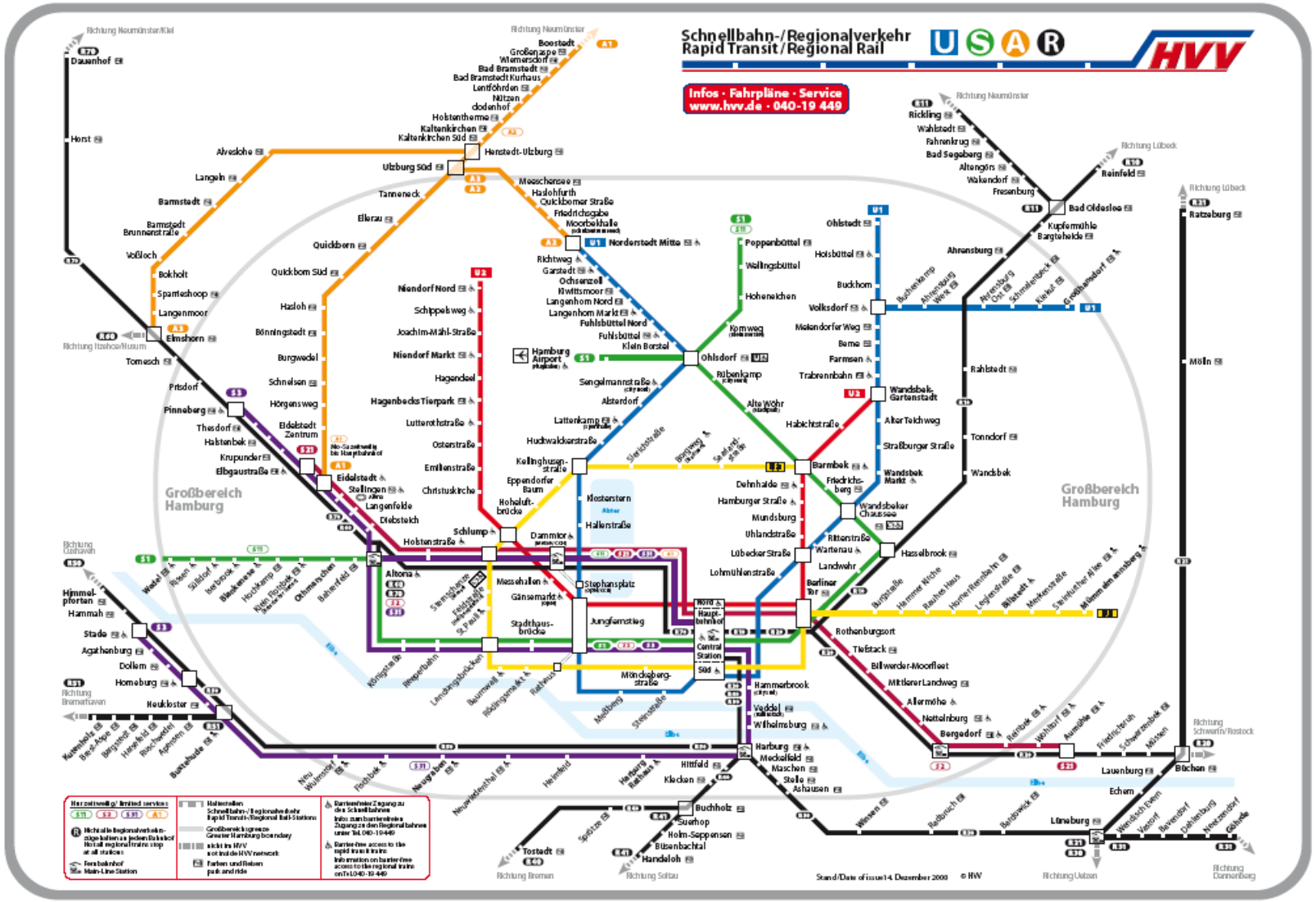
data processing rules

Architecture KBS (in general)



Application: Passenger Information System

Task: **Find the shortest path between specified start and destination in a traffic network**



Basic Technology: Search Strategies

- Construction of search spaces
- Uninformed search strategies
  - breadth-first
  - depth-first
  - combined → special case: Dijkstra‘s algorithm
- Informed search strategies
  → special case: A* algorithmus

Application: Passenger Information System

Personalised dynamic passenger information system (PDPIS)

master thesis Michael Schiefenhövel at FH Wedel (WS 2005/2006)

filtering information for the single passenger

- only information of relevance
- no confusing add-ons
- dynamic arrivals

providing value-added service

- routing adapted to the current situation
- tourist information

Personalised passenger information devices

- individual devices (smartphone, etc.)
- multi-media terminals

Application: Passenger Information System

Personalised dynamic passenger information system (PDPIS)

master thesis Michael Schiefenhövel at FH Wedel (WS 2005/2006)

Passenger information for Hamburg public transport via Smartphones:

diploma thesis Sebastian Hammes (eos-uptrade, SS 2010)

Bachelor thesis Henning Reimer (HBT, SS 2010)

design and implementation of prototypes for:

- iPhone
- Android smartphone

Application: Road Navigation

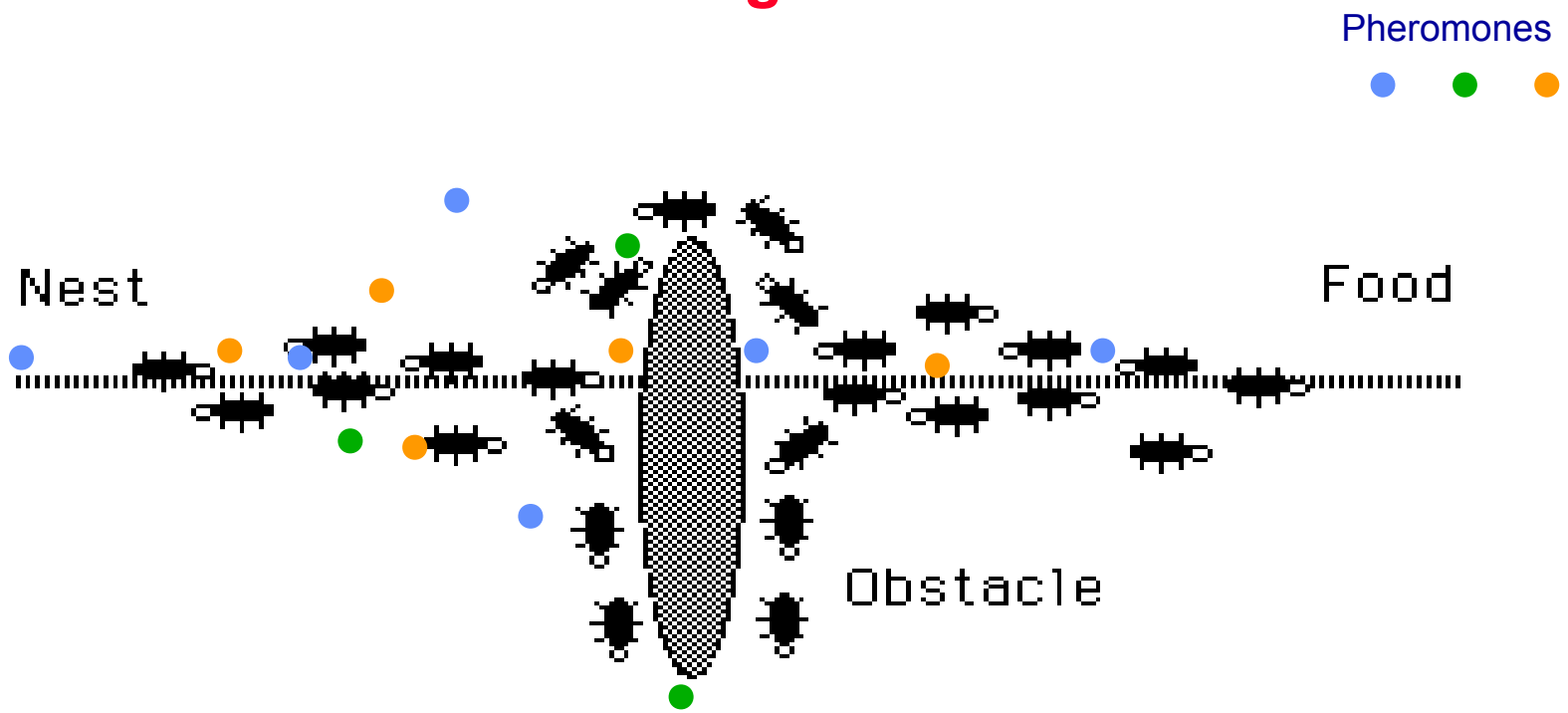
Differences to passenger information:

- road network much more extense
- no time tables
- travel times depend strongly on traffic density
- vehicles are not centrally controlled

Application: Road Navigation

Swarm intelligence: pheromone-based approach

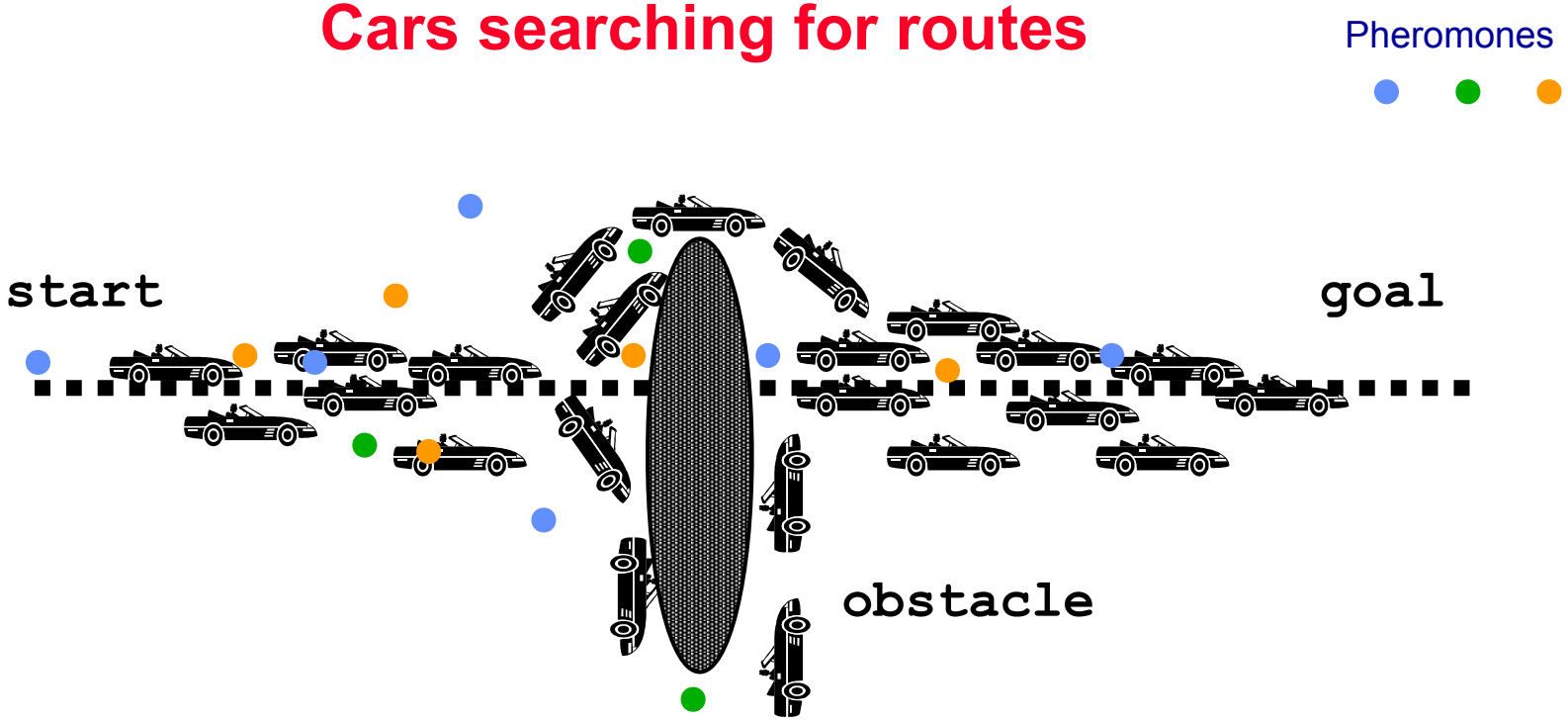
Ants searching for food



Application: Road Navigation

Swarm intelligence: pheromone-based approach

analogue:
Cars searching for routes



Basic Technology: Swarm Intelligence

- high number of little units whose individual ability is limited
- entire organism has more ability than the sum of its individual units (emergent behaviour)
- fixed rules of cooperation for entire organism
- anytime property

Definitions for AI

AI is the science to enable the computer to do things which humans can still do better for the moment

Rich / Knight 1991

AI deals with problems which

- **are relevant in practice.**
- **often cannot be specified exactly.**
- **are NP-complete if they can be specified exactly.**

Iwanowski

Features of Research Communities

The classical antagonism between competing research communities in computer science:

AI vs. Algorithmics

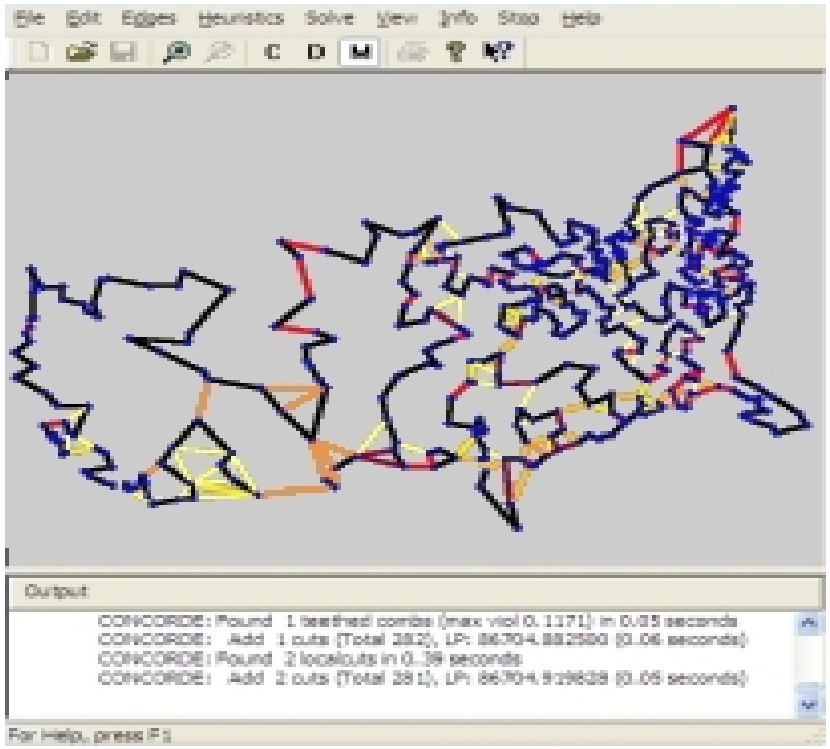
- **flexible**
- **customer oriented**
- **exact**
- **efficient**

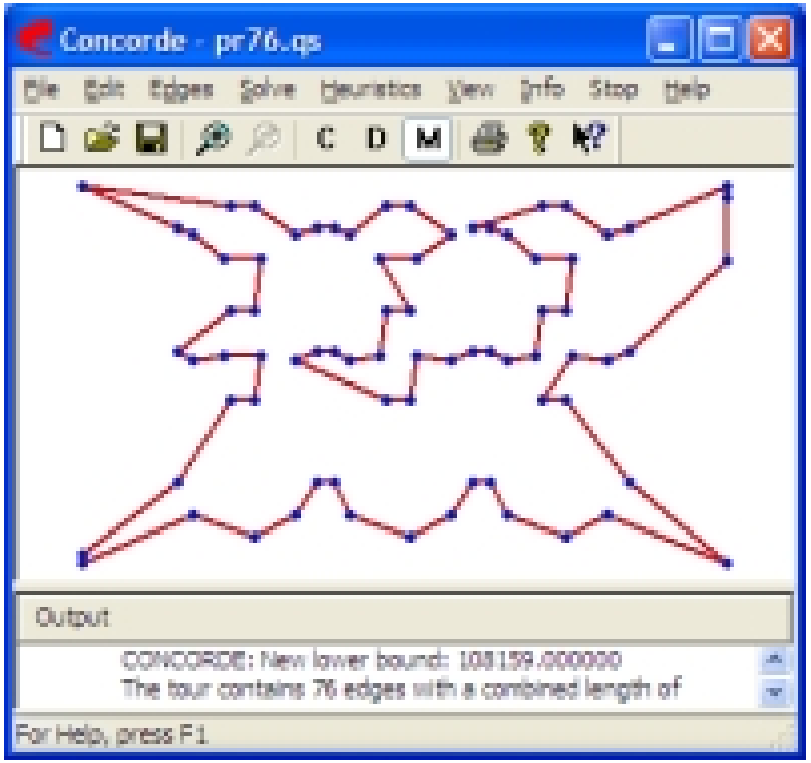
This need not be contradictory!

Application: Traveling Salesman Problem (TSP)

Example for an NP-complete problem:

For a given set of cities with known distances in between, find the shortes round trip passing through each city exactly once.





Quelle: http://www.tsp.gatech.edu//index.html

Application: Traveling Salesman Problem (TSP)

Generalisation for logistic problems:

- **Consideration of temporal contraints (time windows)**
- **Consideration of load capacities**
- **Further application specific contraints**

Example for a final thesis:

Nicolas Woldt: Tour Optimisation in Oil and Gas Applications (SS 2010)

Long-term development project: Tourist Information System

Christoph Forster / Thomas Kresalek: master project Hamburg Tourist Information (2009)

http://vsrv-studprojekt2.fh-wedel.de:8080/touristinformationsystem/home

Solving dynamic problems with ant colony systems

Conclusion of Survey

AI targets for software solutions

- Generality
- Flexibility, extensibility
- Explaining results (only „classical“ AI)

Tools and methods typically used in AI:

- Logic programming languages (PROLOG)
- Object-oriented programming languages (Smalltalk)
- Functional programming languages (Lisp)
- Distributed systems (neuronal networks, multi-agent systems, swarm intelligence)
- Concept hierarchies (ontologies)

Conclusion of Survey

Applications of AI:

- **Diagnosis**
  - **Medical diagnosis**
  - **Technical diagnosis**
- **Optimisation with dynamic parameters**
  - **Passenger information systems**
  - **Road navigation**
  - **Logistics (TSP, Scheduling)**
- **Games**
- **Resource distribution**
- **Information management**
- **…**

Conclusion of Survey

Basic technologies of AI:

- **Knowledge-based systems (special case: expert systems)**
  - Separation of knowledge and inference engine
  - Intelligent knowledge acquisition and representation
  - In focus: Reusability
- **Swarm intelligence**
  - distributed
  - statistic
  - concurrent updates
- **Search strategies**
  - Uninformed vs. informed
  - Search for good or reasonable solutions