

# Collaborative Multi-Expert-Systems: towards more flexibly integrating and processing case-specific and (more) general knowledge

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# The DFKI research labs



**Saarbrücken**



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**Bremen**

Intelligent  
User Interfaces  
Prof. Wahlster

Knowledge  
Management  
Prof. Dengel

Robotics  
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Language Technology  
Prof. Uszkoreit

Augmented Vision  
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Systems  
Prof. Drechsler

Agents and  
Simulated Reality  
Prof. Slusallek

Embedded Intelligence  
Prof. Lukowicz

Institute for  
Information Systems  
Prof. Loos

Center for Human-  
Machine Interaction  
Prof. Zühlke

Associated Labs

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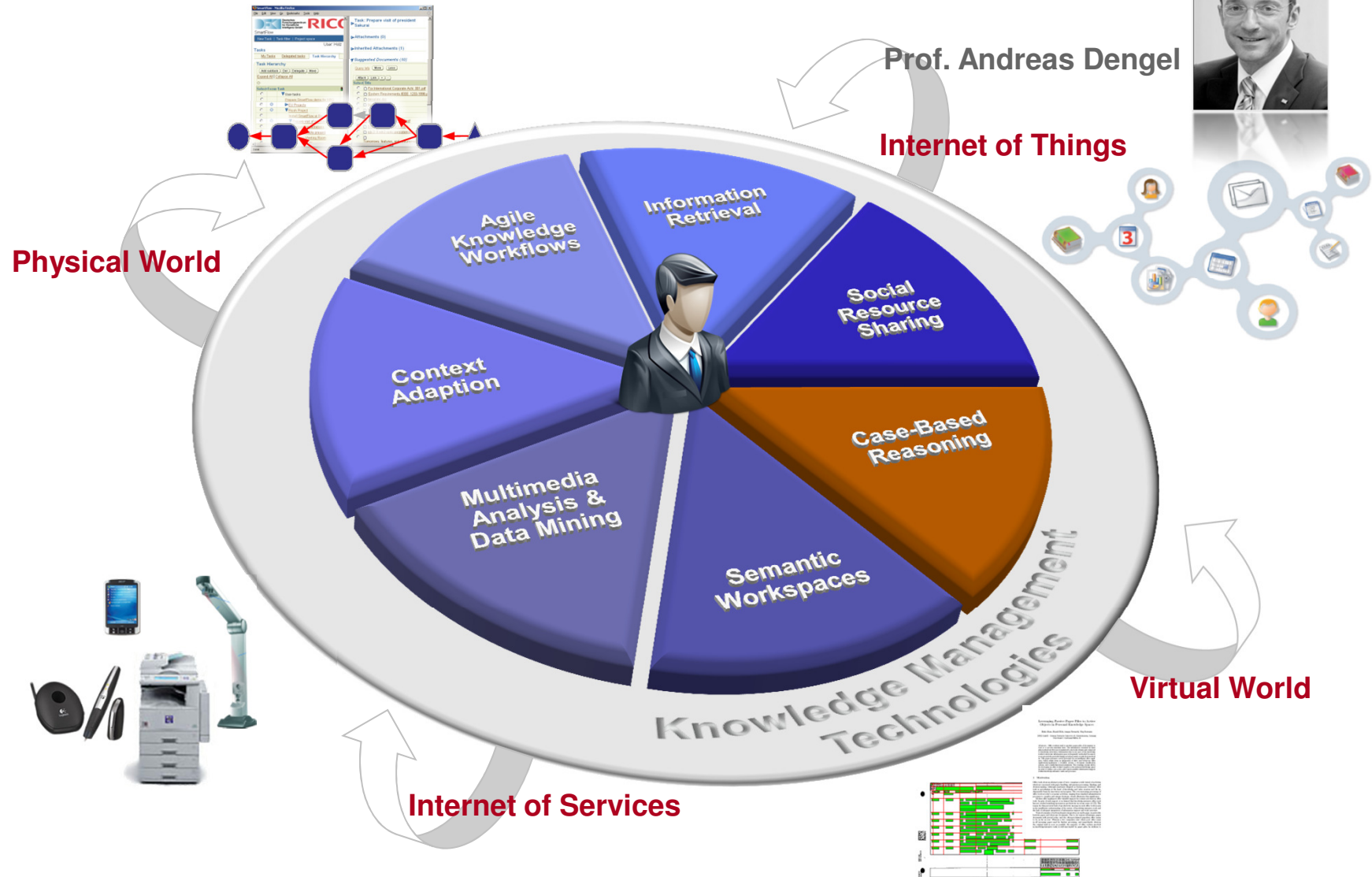
Embedded Intelligence  
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# The Knowledge Management Department aims at the technological support of knowledge workers



Prof. Andreas Dengel

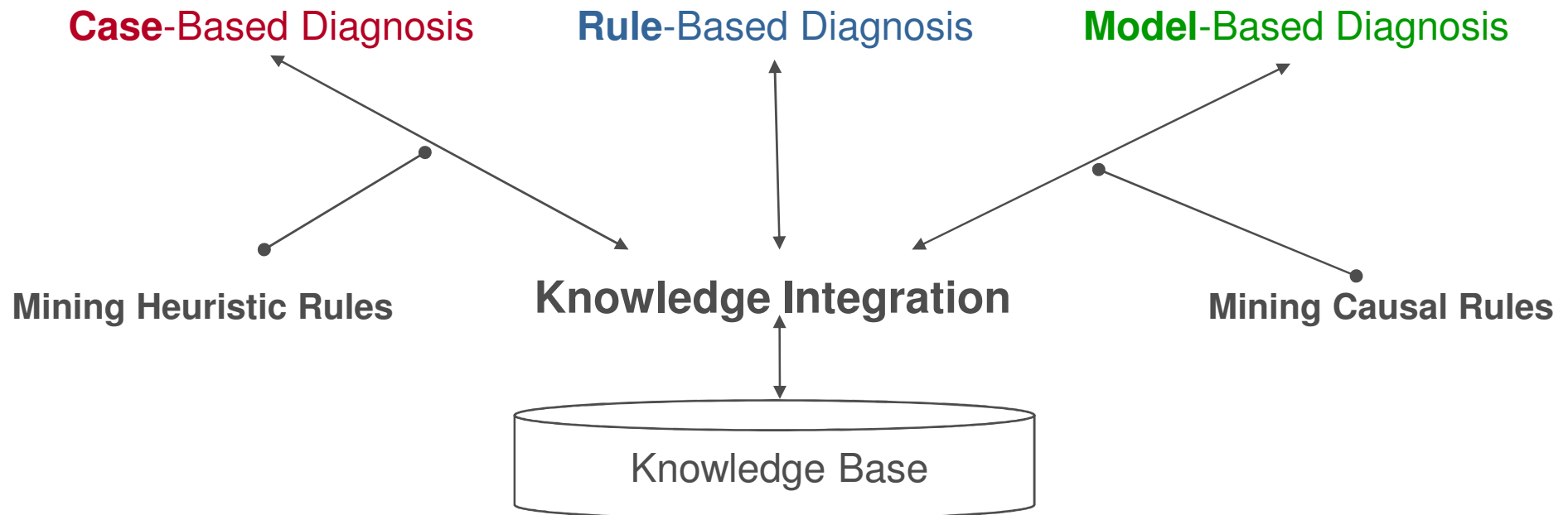
# Collaborative Multi-Expert-Systems: towards more flexibly acquiring, integrating, and processing case- specific and (more) general knowledge

Klaus-Dieter Althoff

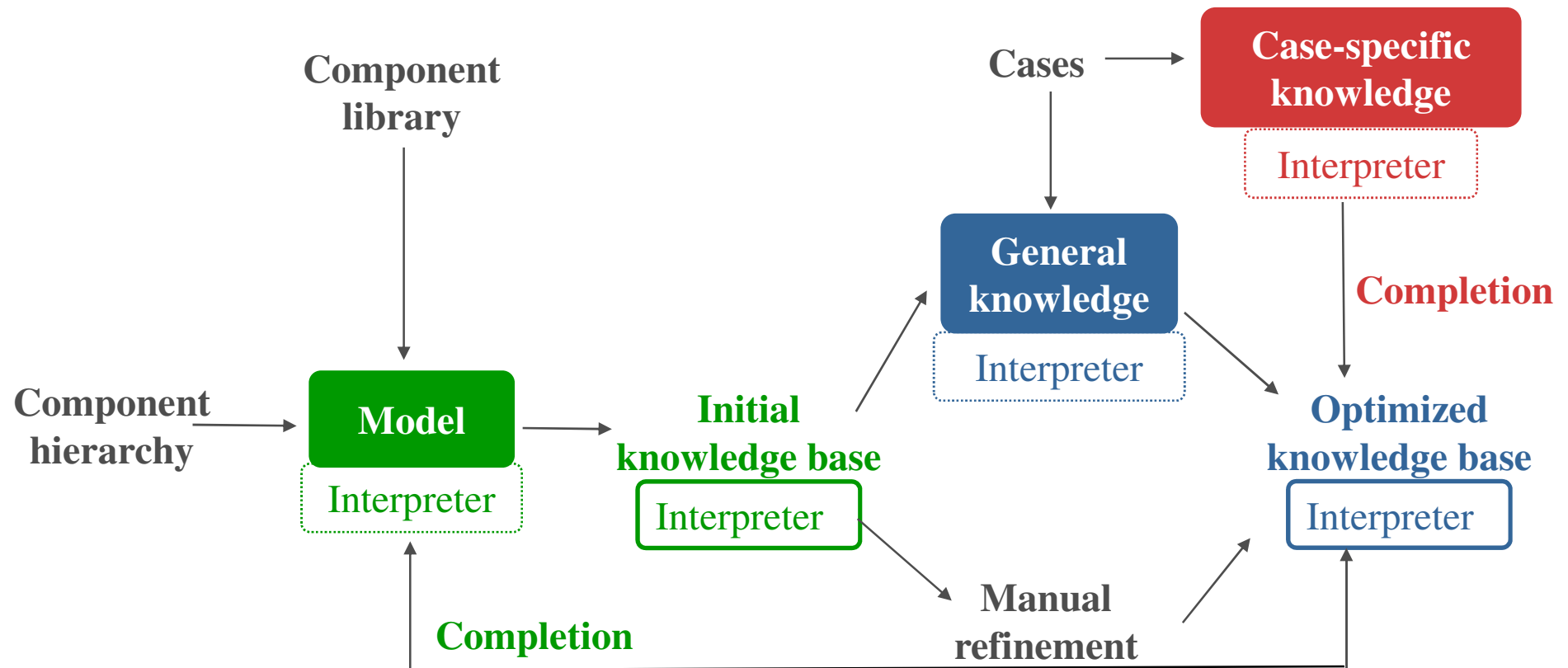
**University of Hildesheim, Institute of Computer Science**  
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Klaus-Dieter.Althoff@dfki.de

- ▶ Case-based reasoning (CBR) and expert systems have a long tradition in artificial intelligence
  - Expert systems since the late 1960s.
  - Expert systems are based on expertise and expert reasoning capabilities for a specific area of responsibility
  
  - CBR since the late 1970s
  - CBR is an approach for problem solving and learning of humans and computers.
  
- ▶ MOLTKE project on technical diagnosis
  - Different techniques for technical diagnosis
  - Different roles CBR can play here

# Different Reasoning Strategies for Technical Diagnosis

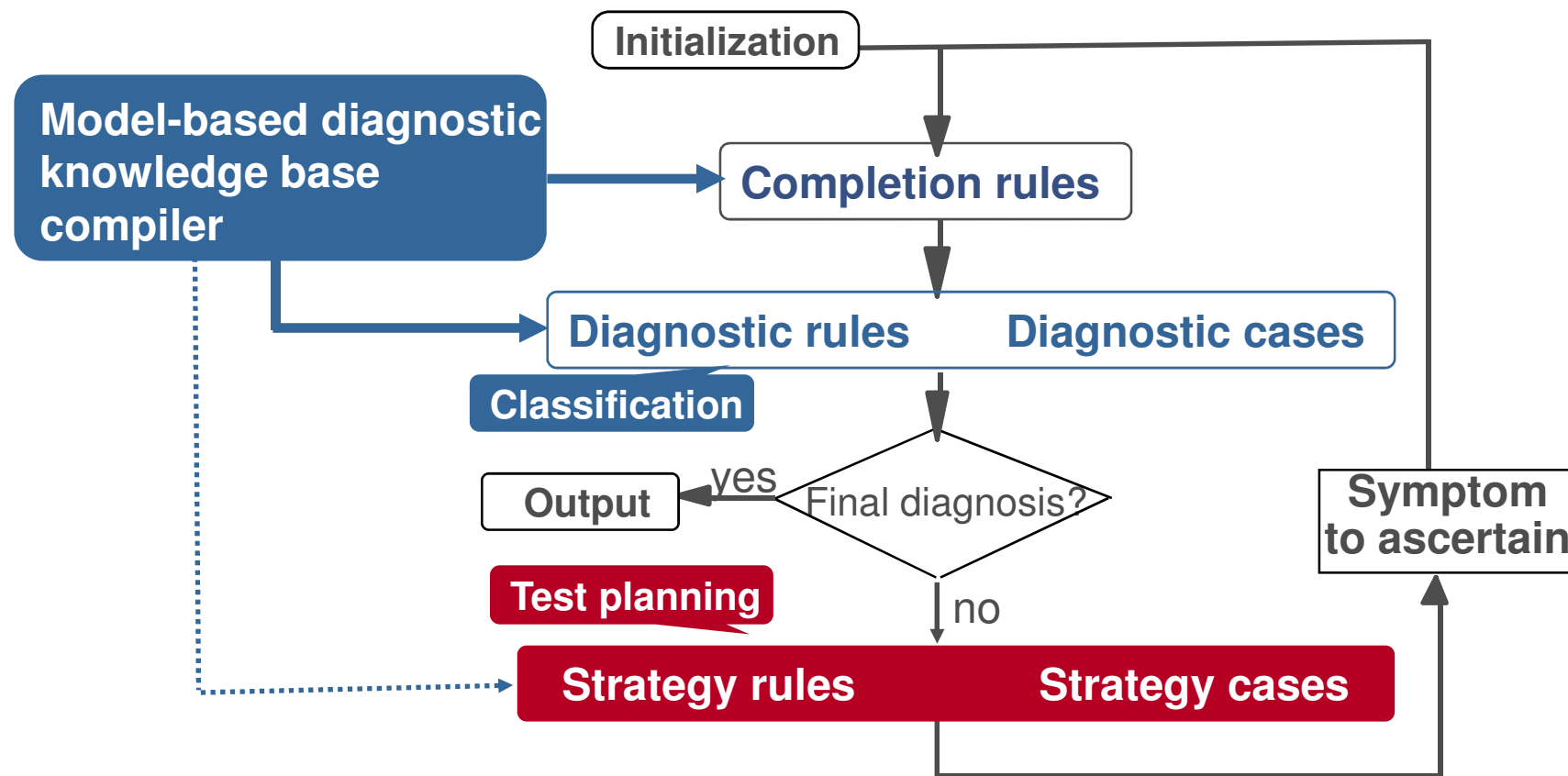


# Model-Based, Associative Diagnostic System (MOLTKE)





# Model-Based and Associative Diagnostic Reasoning

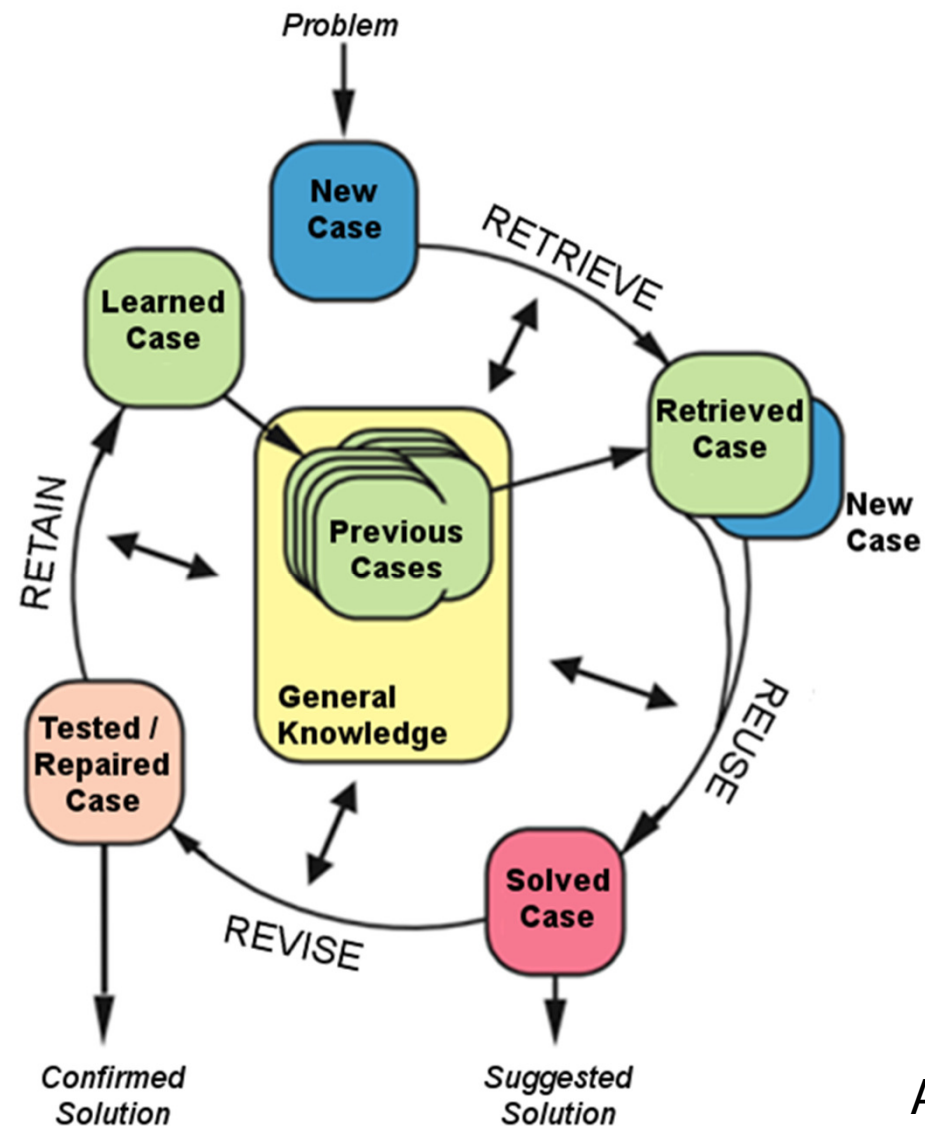


- ▶ Achievements and challenges
  - Knowledge acquisition bottleneck
  - Ontologies / semantic web technologies
  - Expertise modeling
  - Artificial Intelligence and Software Engineering
- ▶ Learning from humans to improve expert systems
  - Integrating problem-solving and learning
  - Combining different problem solving strategies
  - Utilizing different kinds of knowledge
  - Becoming experts for specific areas of responsibility
- ▶ Since humans do all these processes as background jobs, we need a scientific approach that easily supports us to develop expert systems with such abilities
  - Potential of CBR to become a core part of future expert systems

- ▶ Expertise
- ▶ Learning on different levels
- ▶ Community: extending memory
- ▶ Knowledge extraction
- ▶ Knowledge advancement (Wissensweiterentwicklung)
- ▶ Results
- ▶ Outlook

- ▶ Advancing the acquisition of ability to perform
  - Misunderstanding 1: Much knowledge results in an expert
  - Misunderstanding 2: Practicing a lot results in an expert
  - Experience as reflecting practice: Knowledge and problem solving in social context
    - Gruber & Rehr (2003)
- ▶ Expertise=knowledge+experience
  - Learning as developing and advancing expertise
  - Implementation by means of memory
  - Learning agents: Case-Based Reasoning

# Case-Based Reasoning (CBR)



Aamodt & Plaza 1994

- ▶ Advancing the acquisition of ability to perform
  - Misunderstanding 1: Much knowledge results in an expert
  - Misunderstanding 2: Practicing a lot results in an expert
  - Experience as reflecting practice: Knowledge and problem solving in social context
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  - Implementation by means of memory
  - Learning agents: Case-Based Reasoning
  - Knowledge intensive CBR
  - Knowledge containers

# Knowledge Containers

## ▶ Vocabulary

- Defines the structure of the cases and the used terminology

## ▶ Case Base

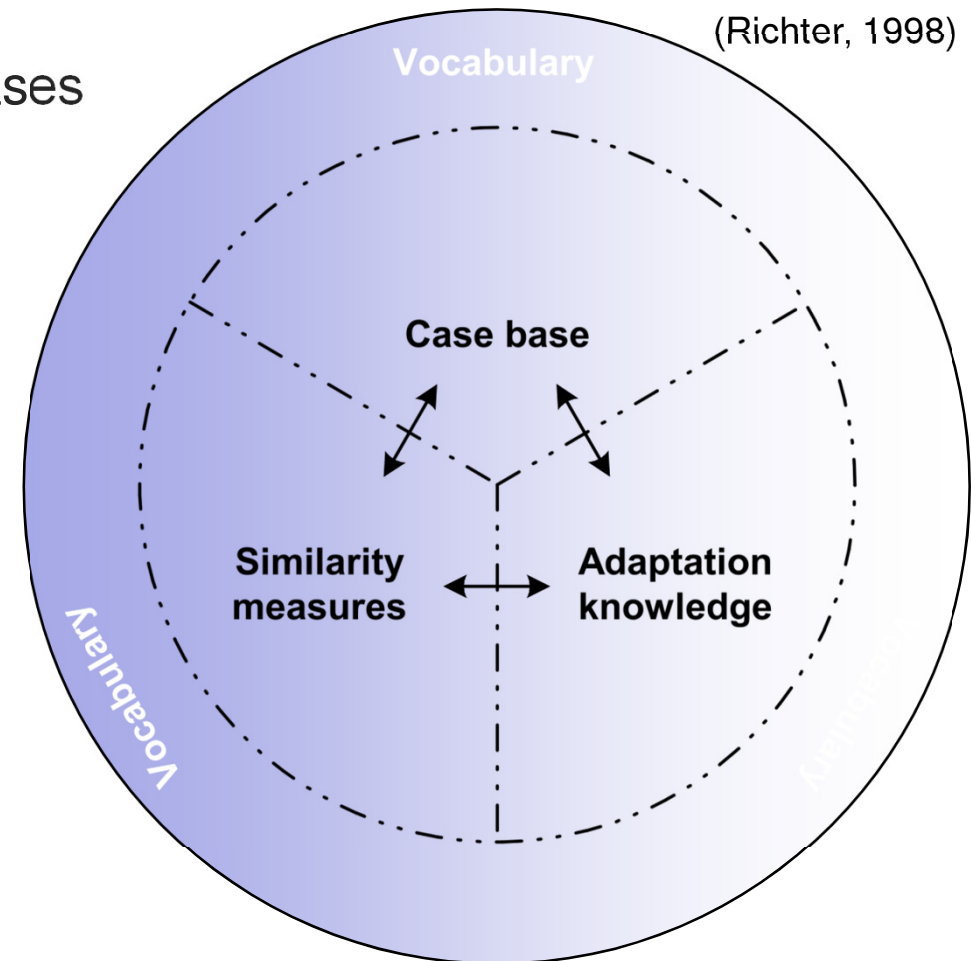
- Situation-specific knowledge / experiences

## ▶ Similarity Measures

- Define how to compare cases

## ▶ Adaptation Knowledge

- Defines how to adapt cases



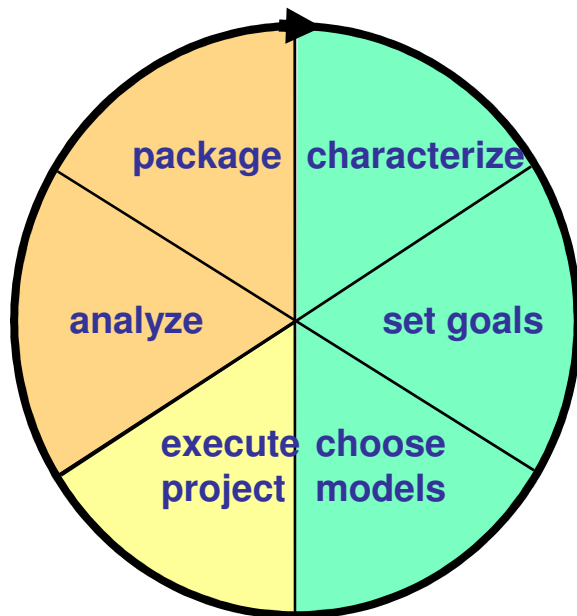
# Learning on different levels

- ▶ Experience Factory -> Case Factory
  - Organizational learning -> agent support for learning of agents

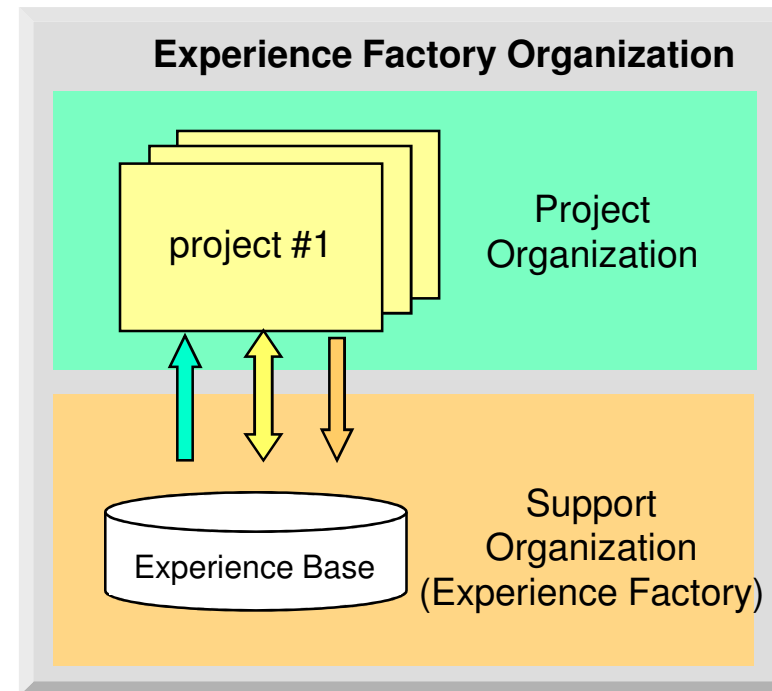


# Experience Factory and Quality Improvement Paradigm

## Quality Improvement (QIP) Paradigm (Basili, Rombach, 1988)



## Experience Factory (EF) Organization (Basili, Rombach, 1988)



# CBR Task-Method Decomposition

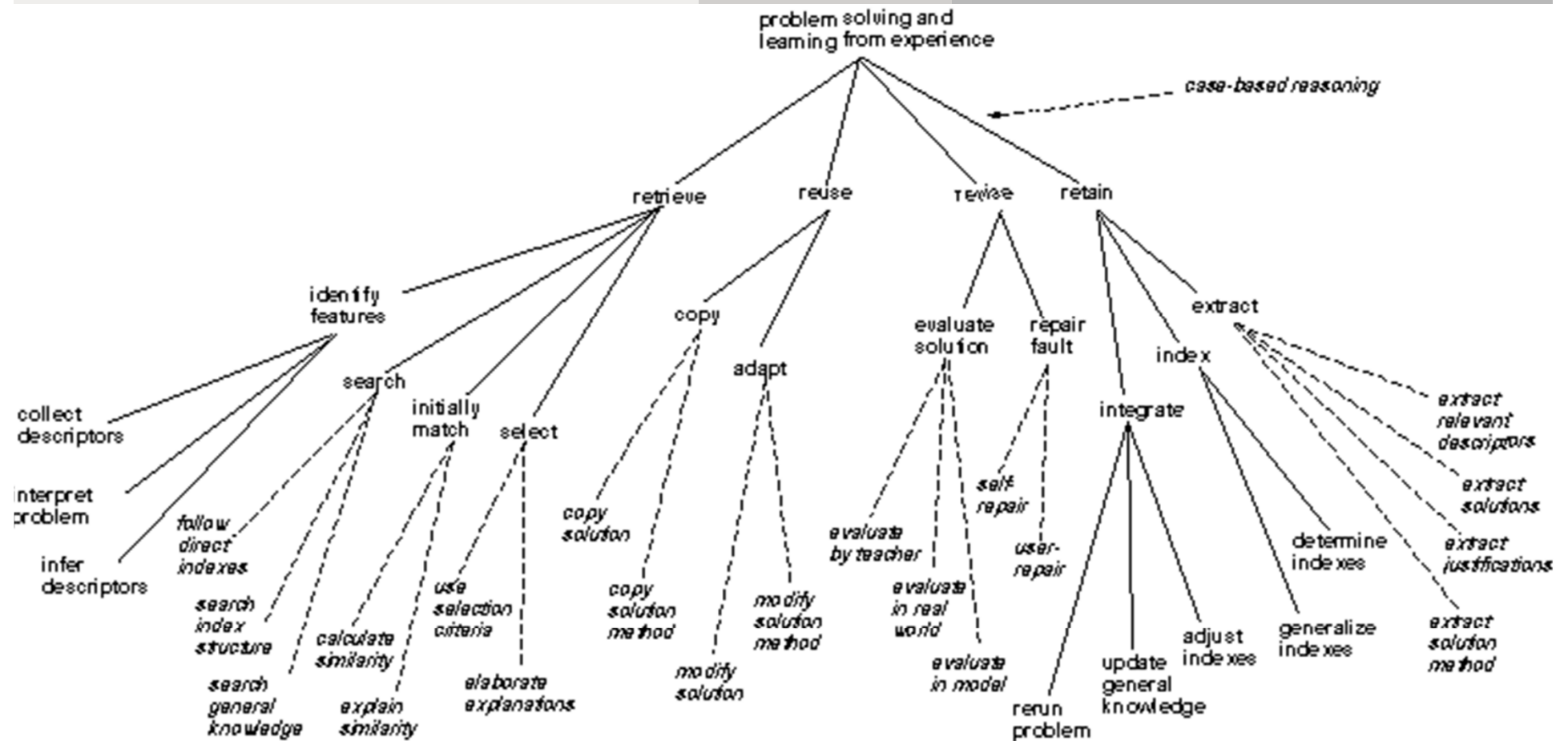
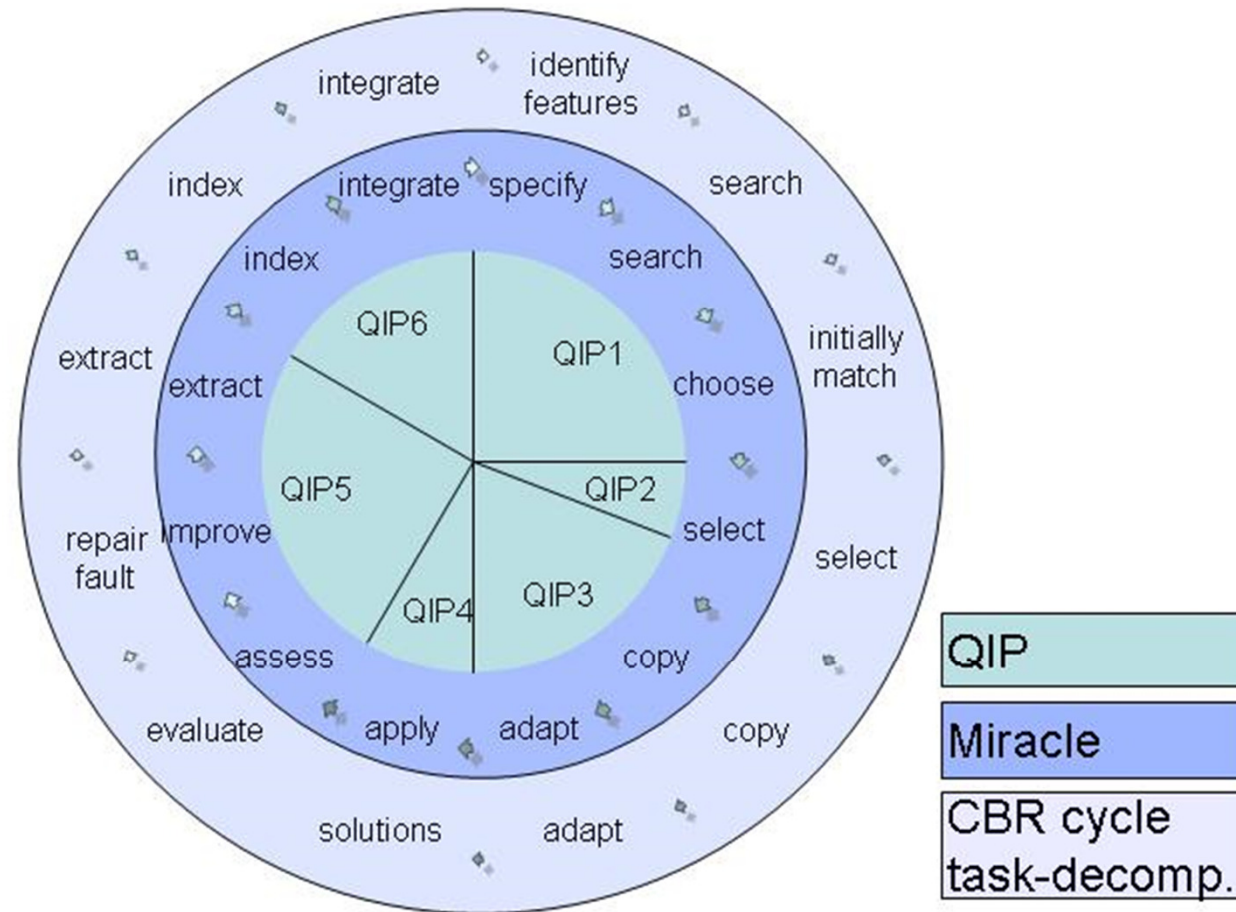


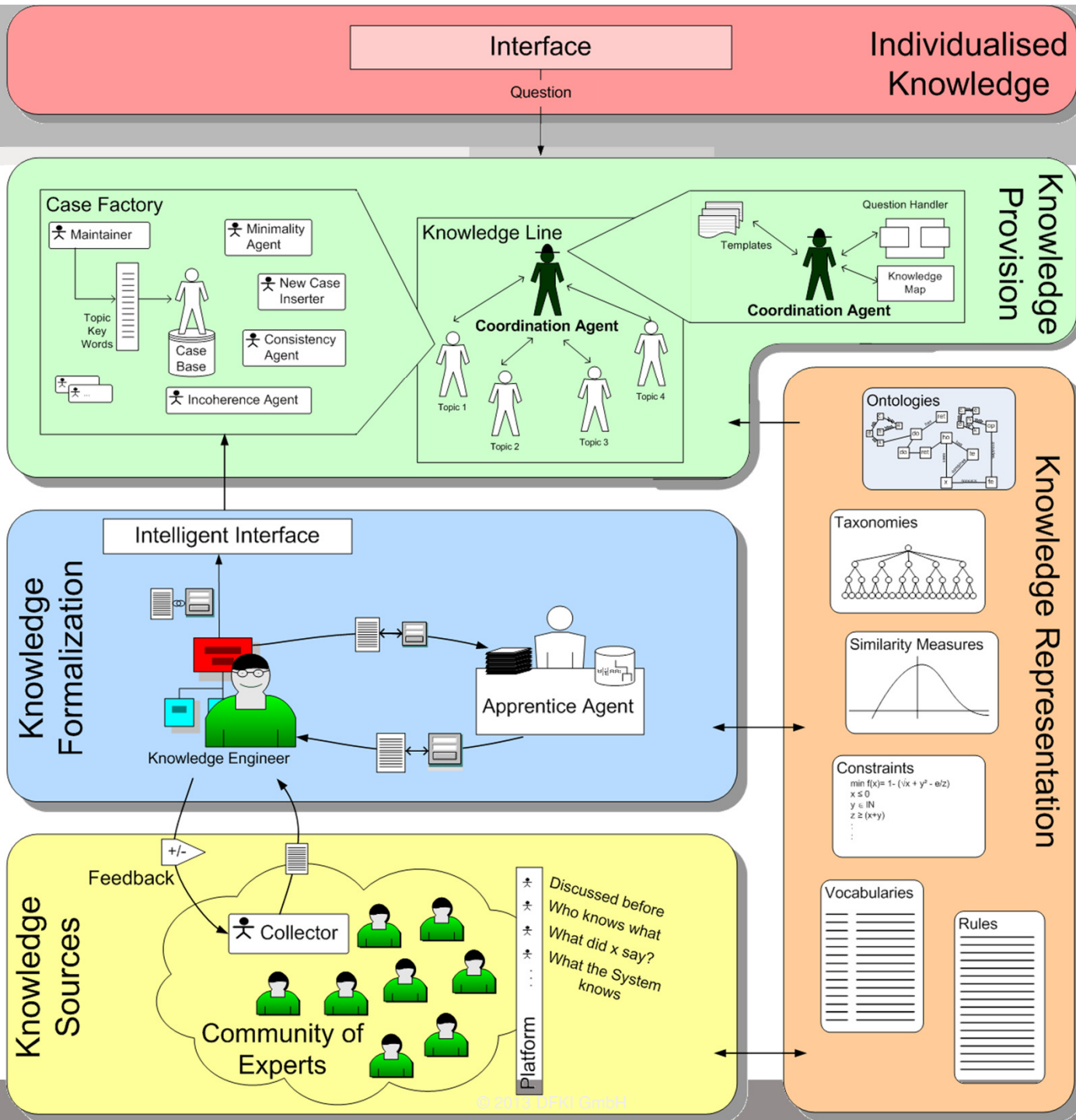
Figure 2. A task-method decomposition of CBR

Aamodt & Plaza 1994

# Relating CBR and EF/QIP



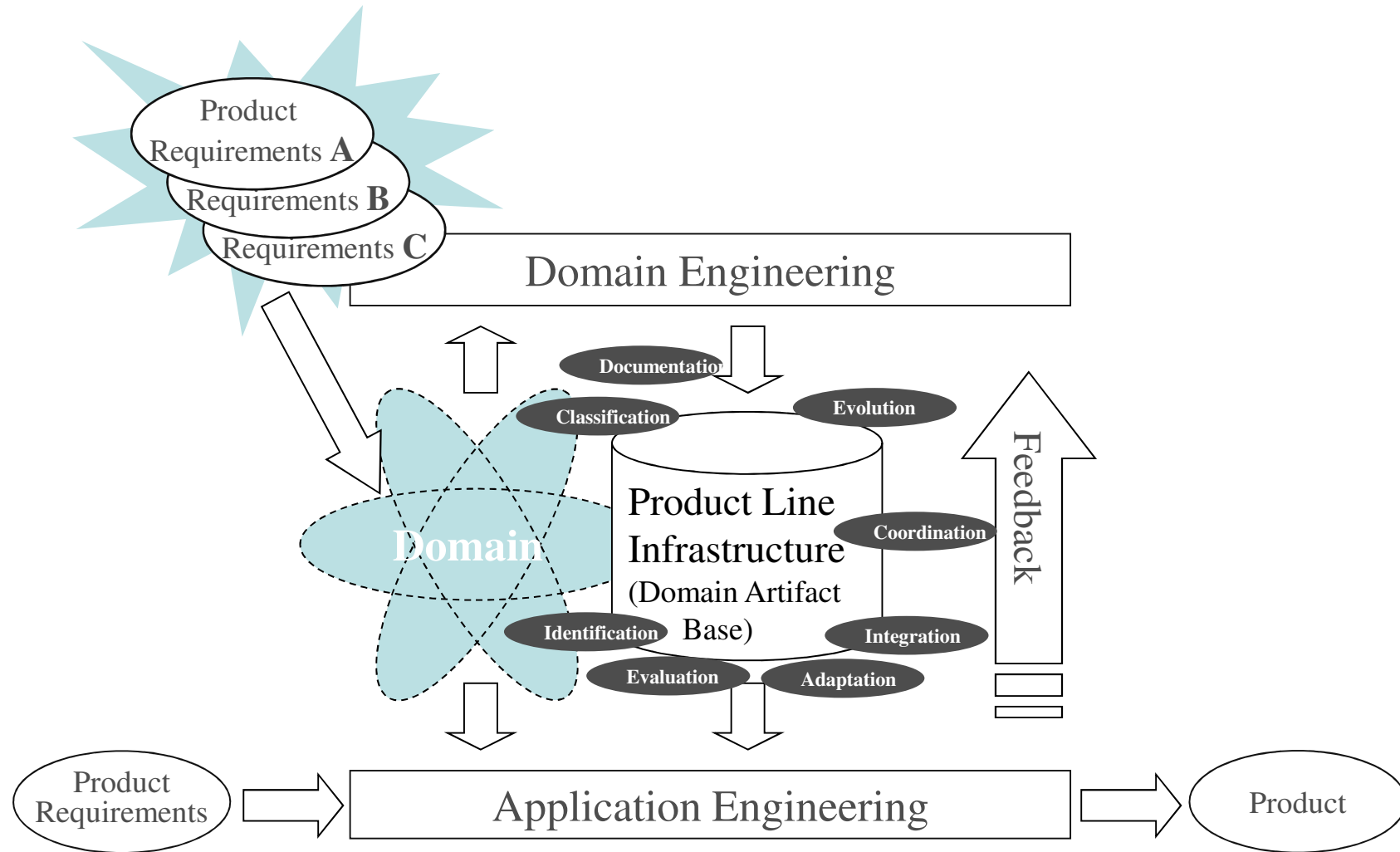
# SEASALT



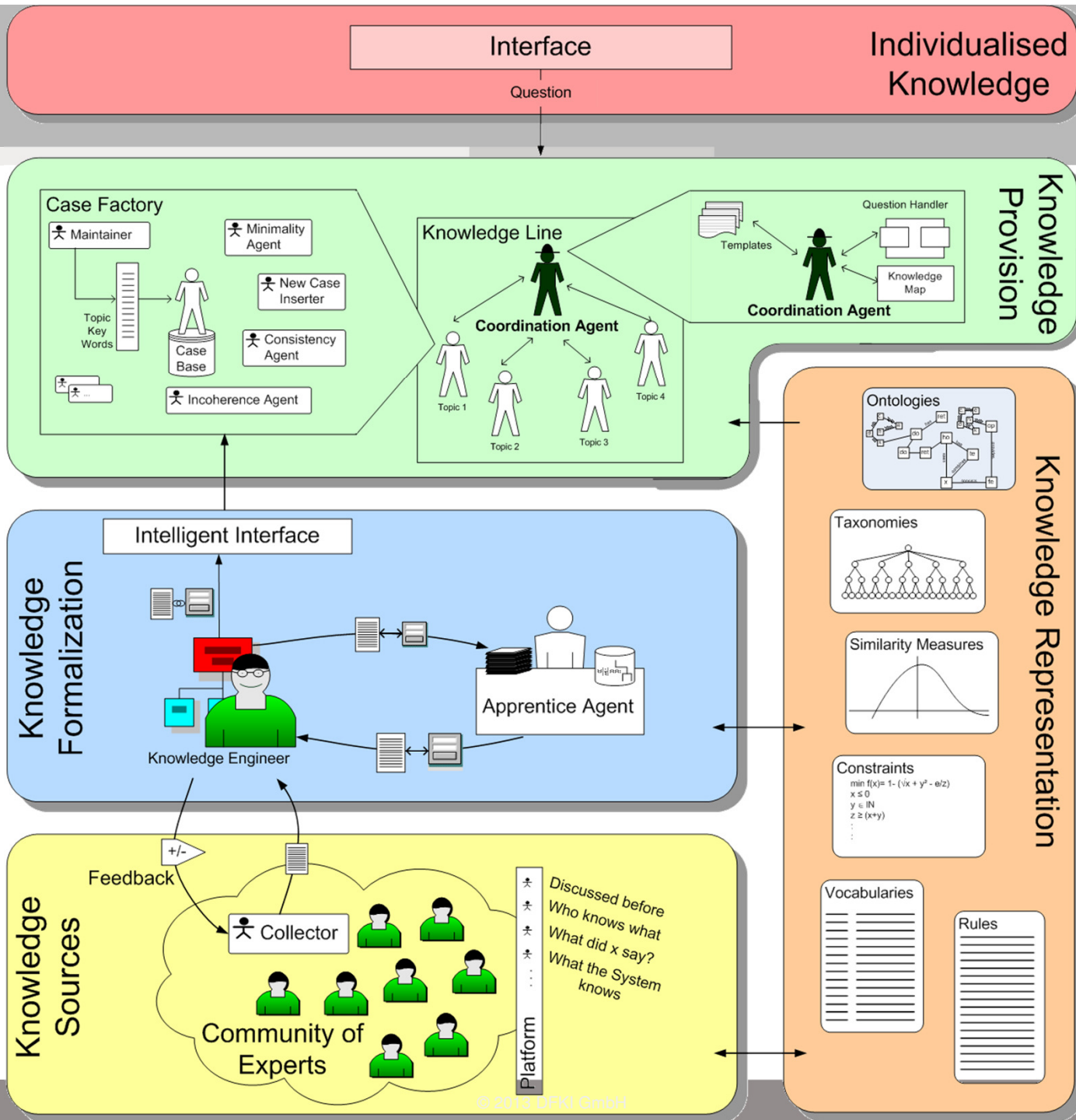
# Lernen on different levels

- ▶ Experience Factory -> Case Factory
  - Organizational learning -> agent support for learning of agents
- ▶ Software product line -> knowledge line
  - Decomposition to make learning easier

# Software Product Lines



# SEASALT

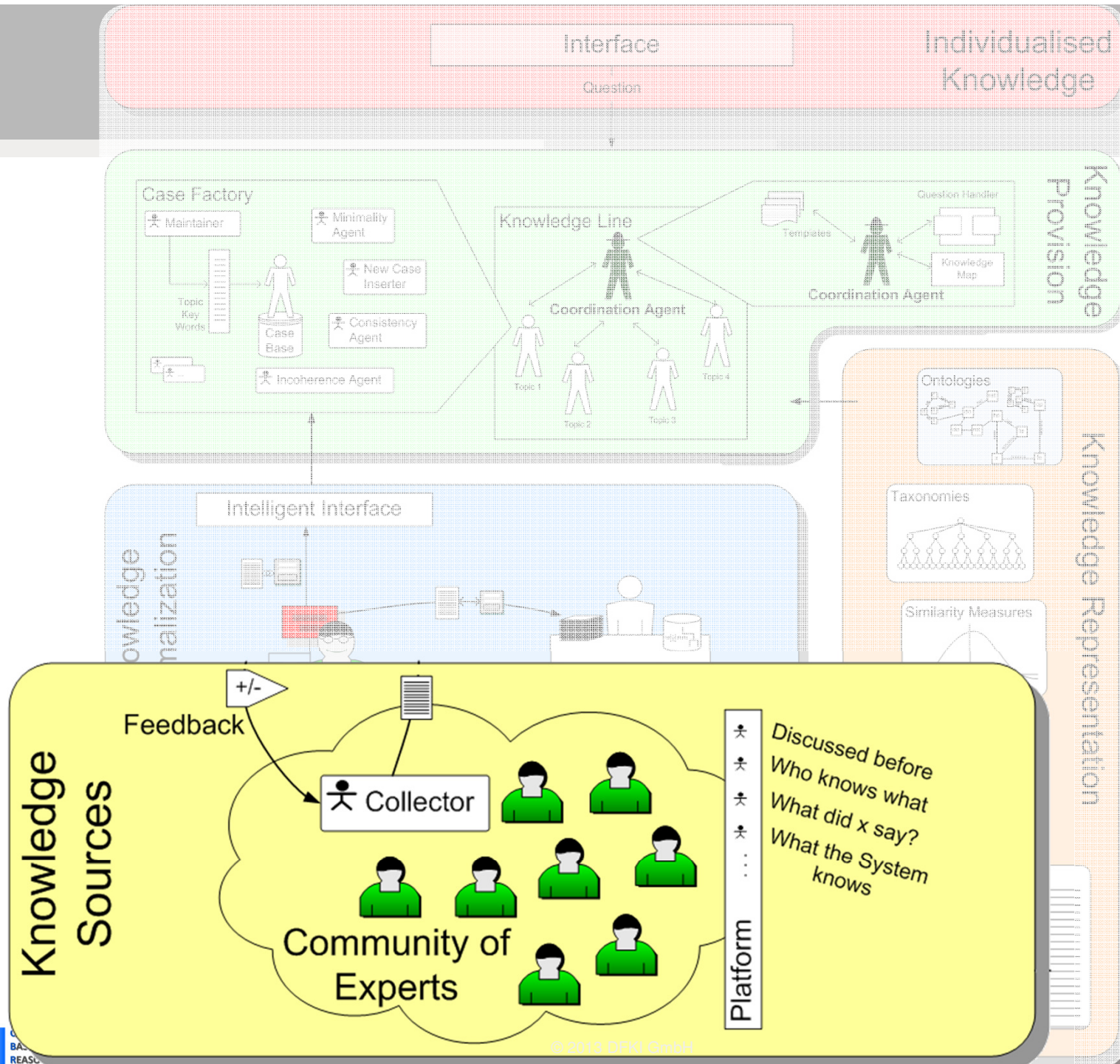


# Learning on different levels

- ▶ Experience Factory -> Case Factory
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- ▶ **Community: Extending memory**
  - Also: Memory for communities



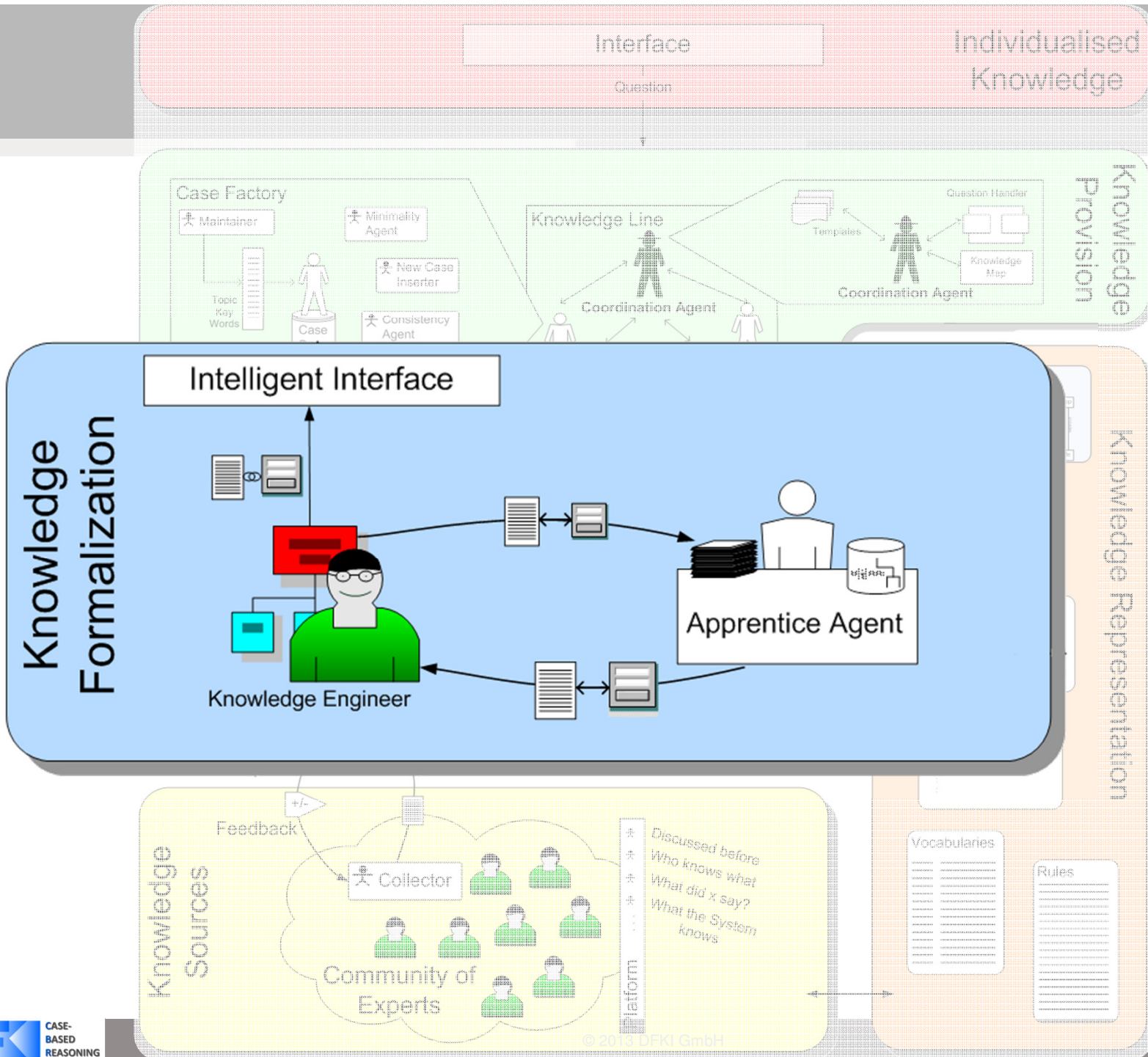
# SEASALT



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- ▶ Knowledge extraction: Filling the knowledge containers

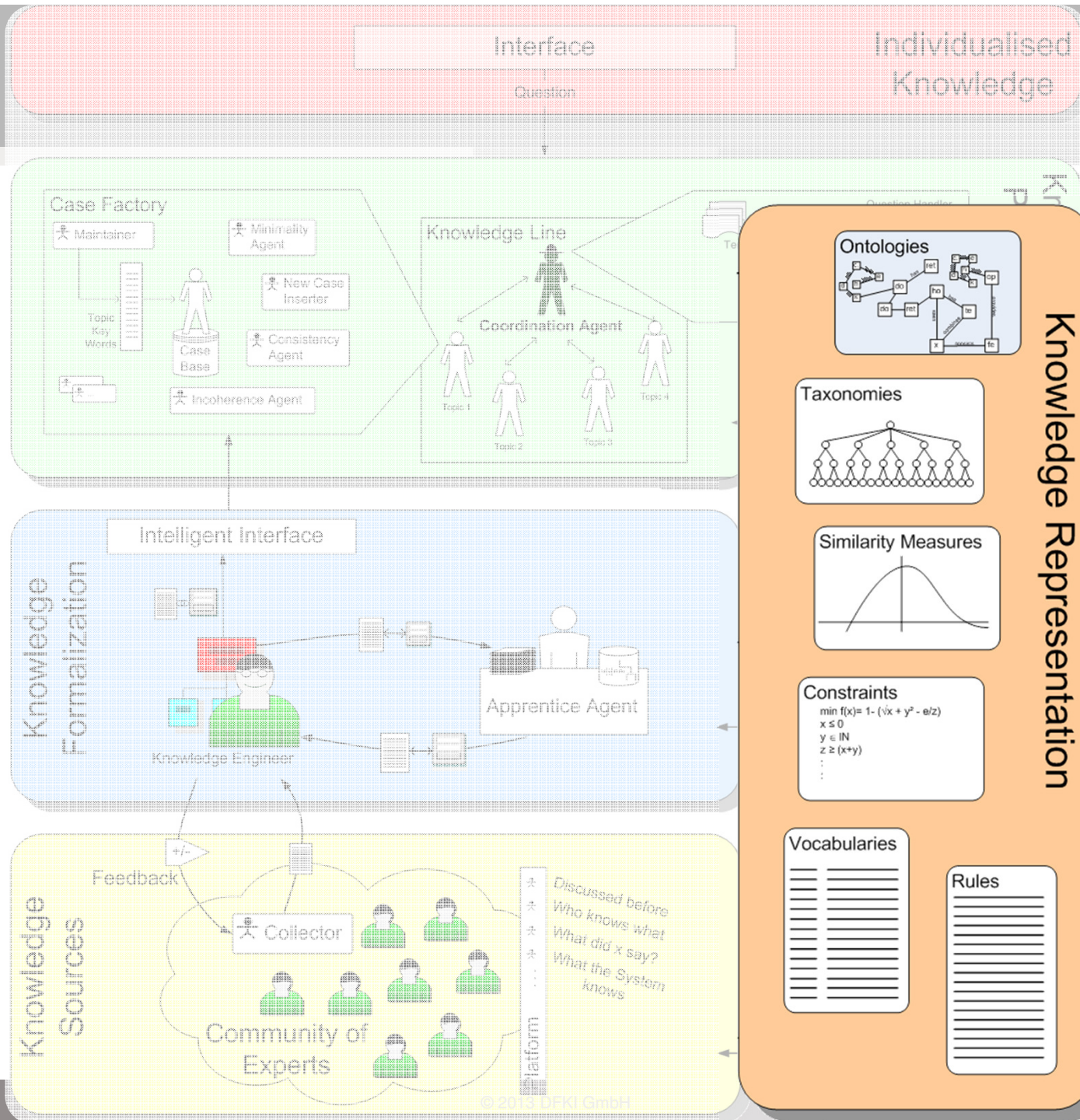
# SEASALT



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- ▶ Knowledge advancement
  - Learning general knowledge from experience
  - Importance of context
  - Using (further) semantic technologies

# SEASALT

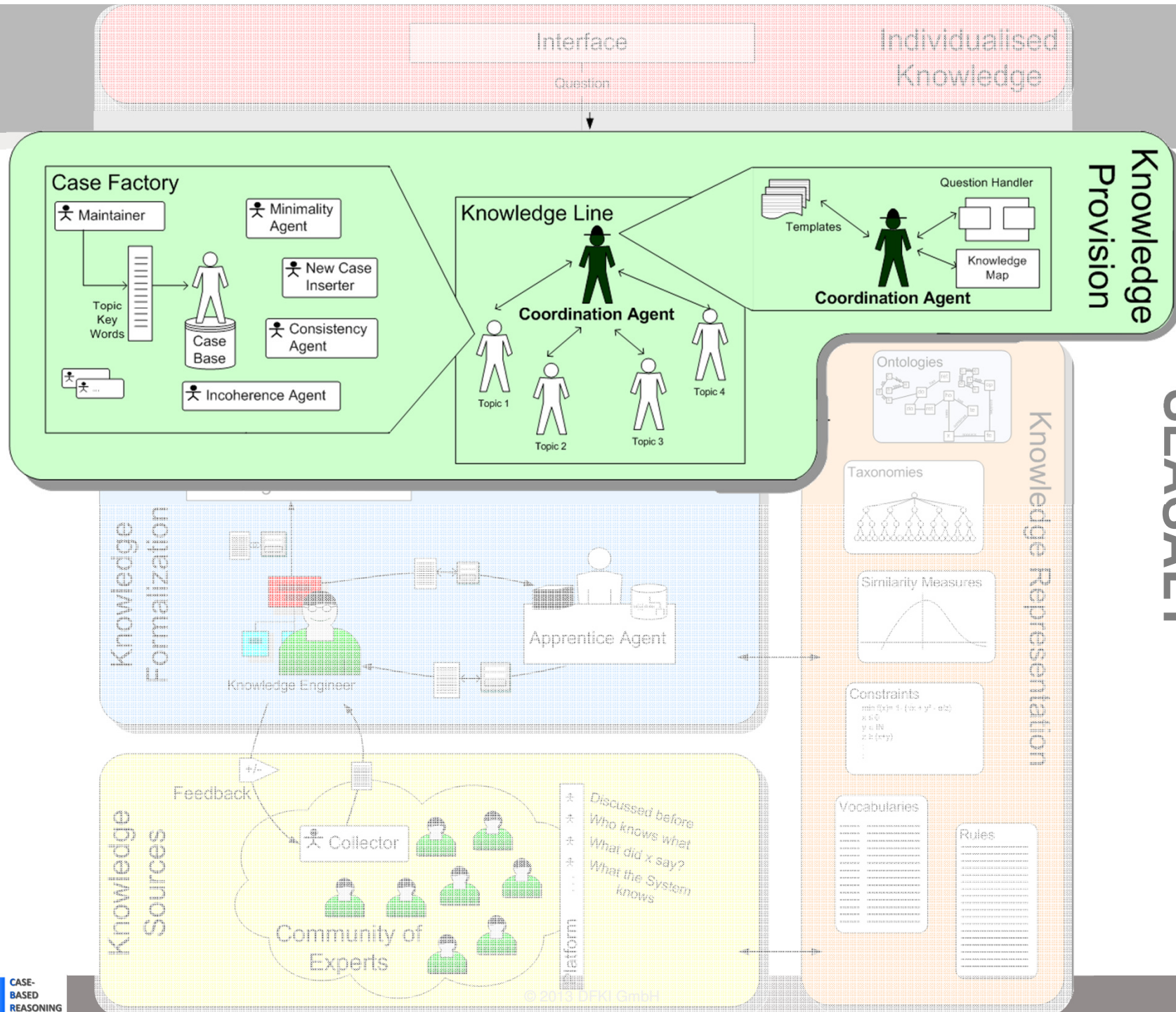


# Learning on different levels

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  - Using (further) semantic technologies
- ▶ **Maintaining the knowledge base -> learning of the agent**
  - **Maintaining the knowledge base -> explanation ability of the agent**



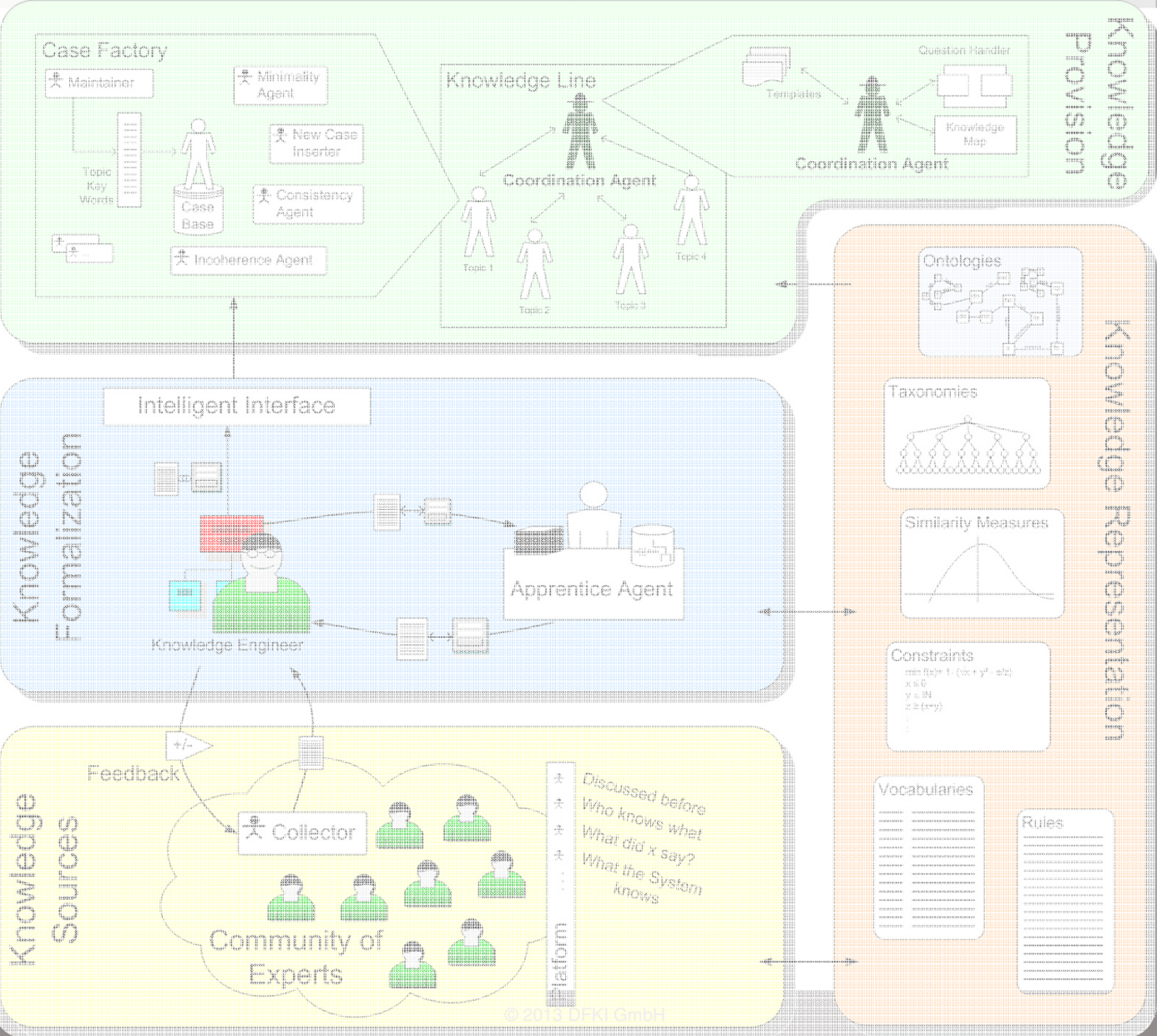
# SEASALT



Interface

Question

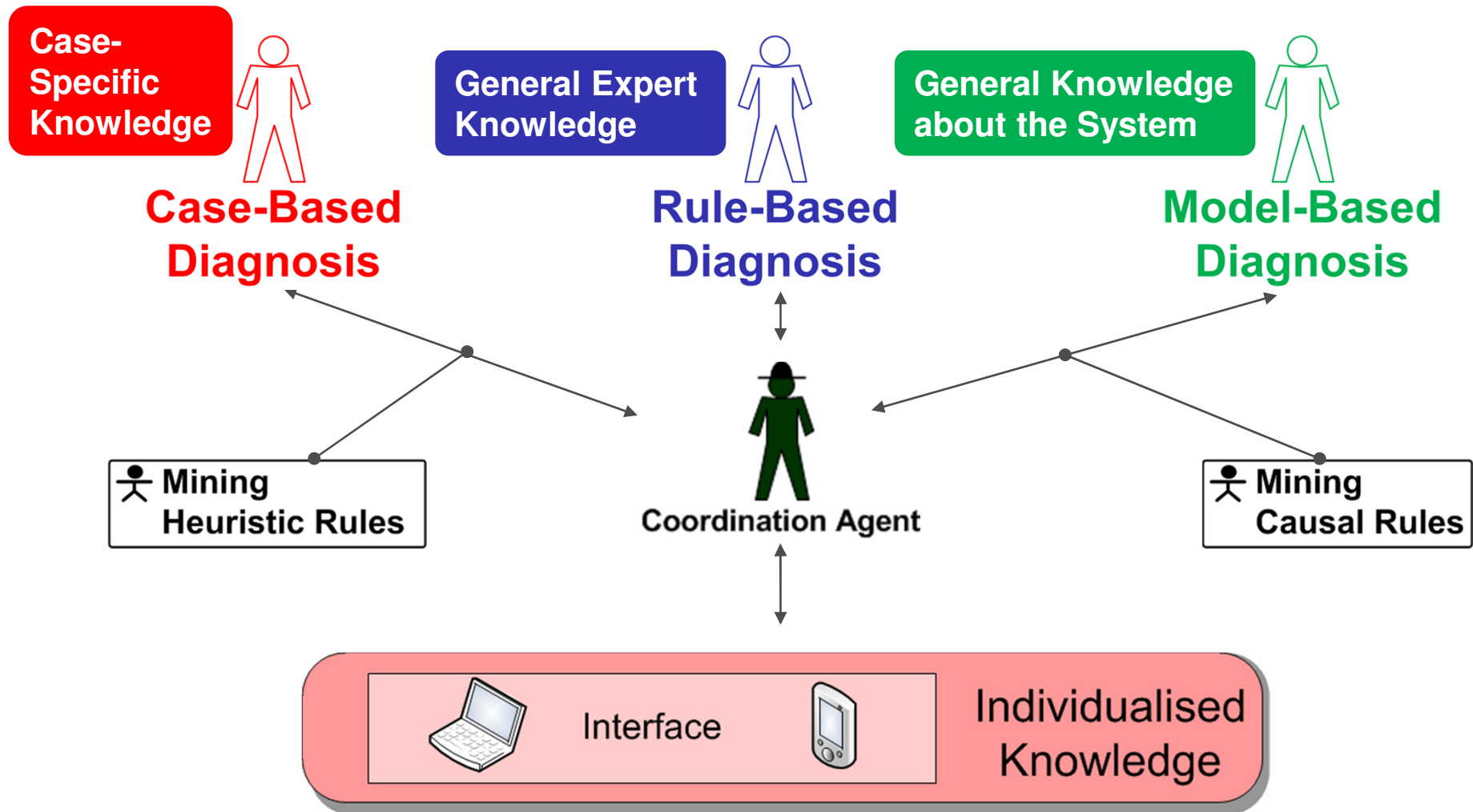
Individualised Knowledge



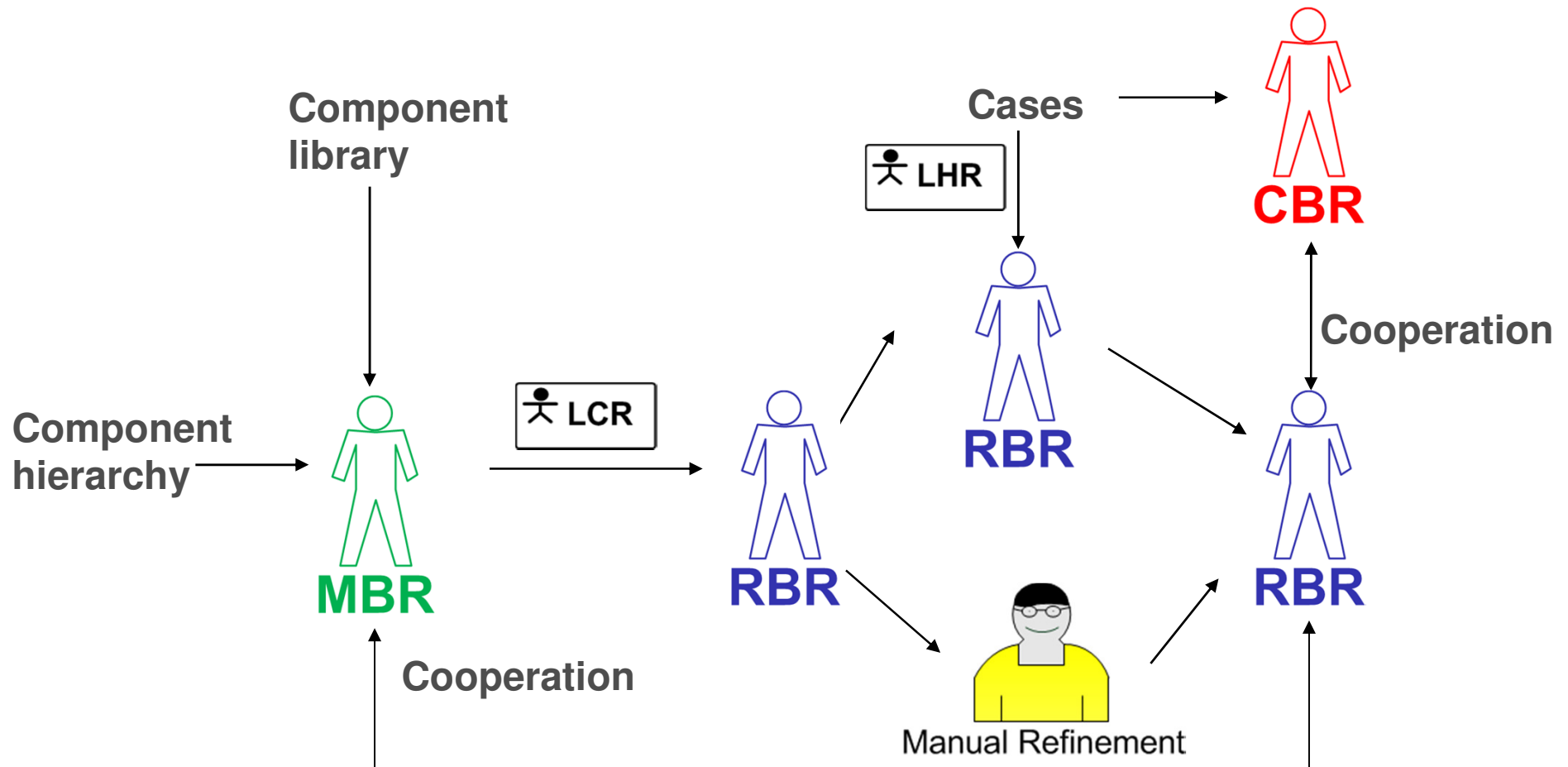
SEASALT



# Agent-oriented modeling for technical diagnosis using SEASALT

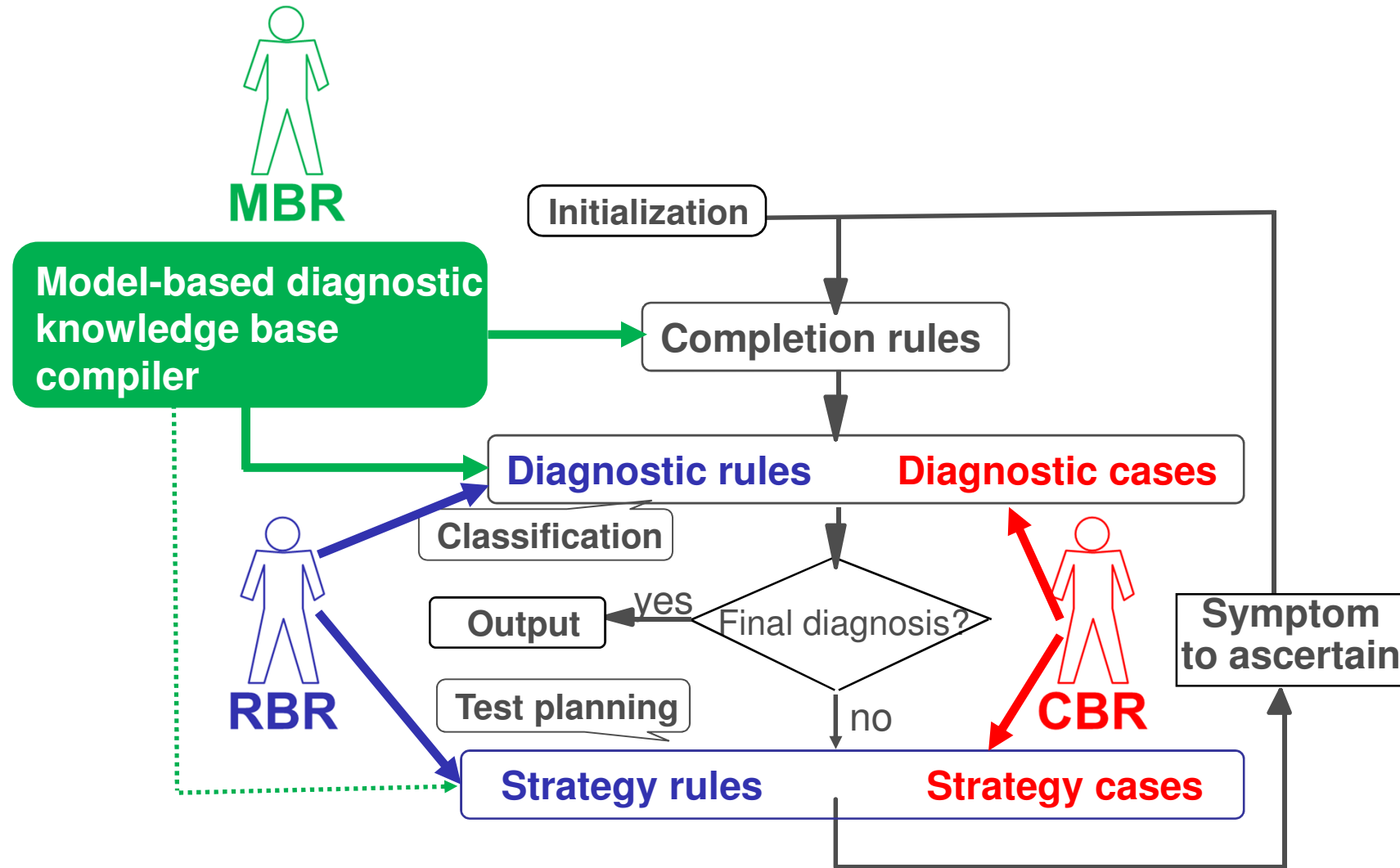


# Integrated diagnostic reasoning based on SEASALT agents

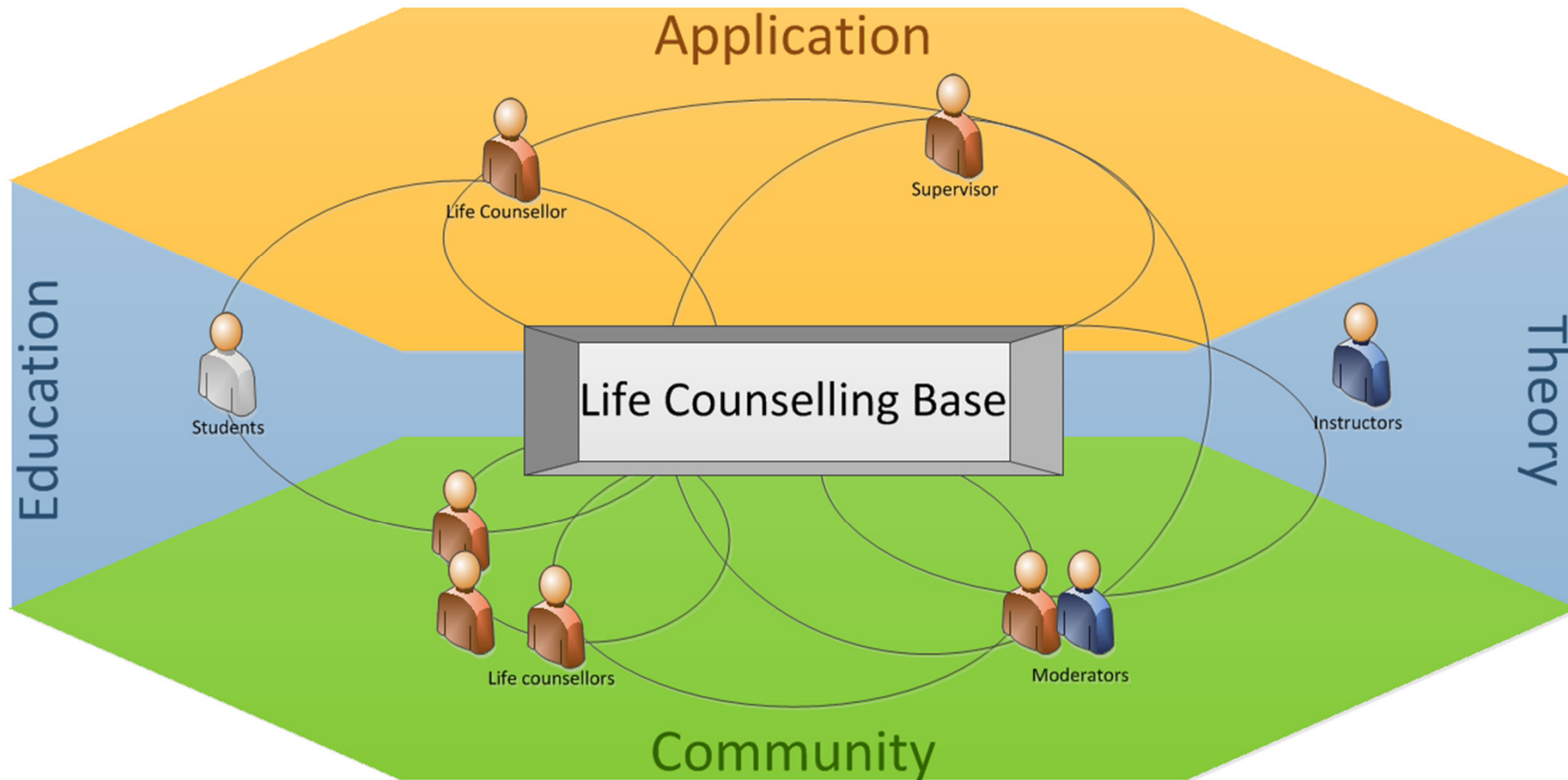


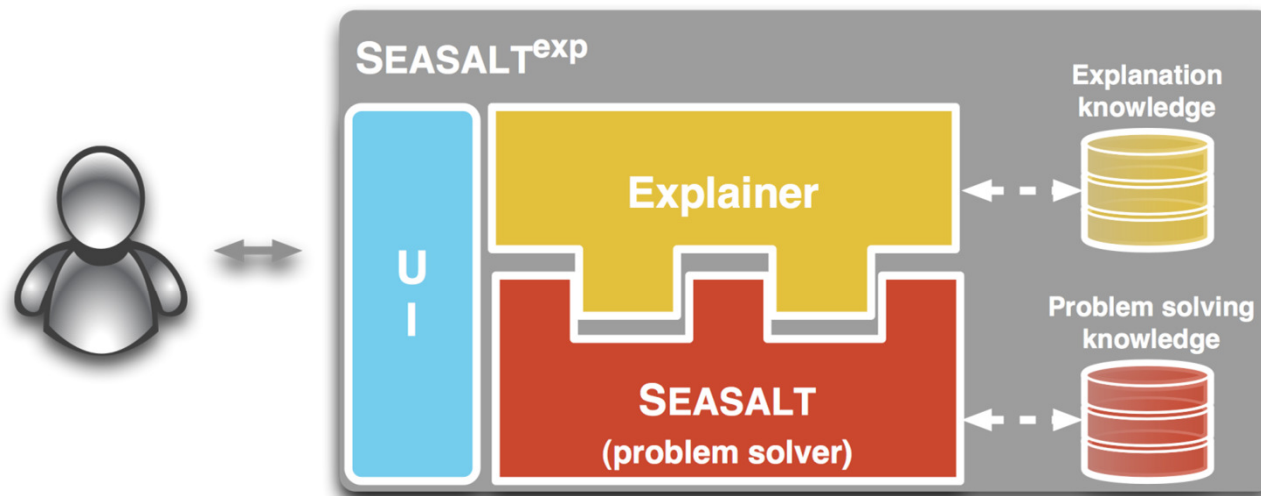
**MBR**=Model-based reasoning **RBR**=Rule-based reasoning **CBR**=Case-based reasoning  
LHR=Learning heuristic rules LCR=Learning causal rules

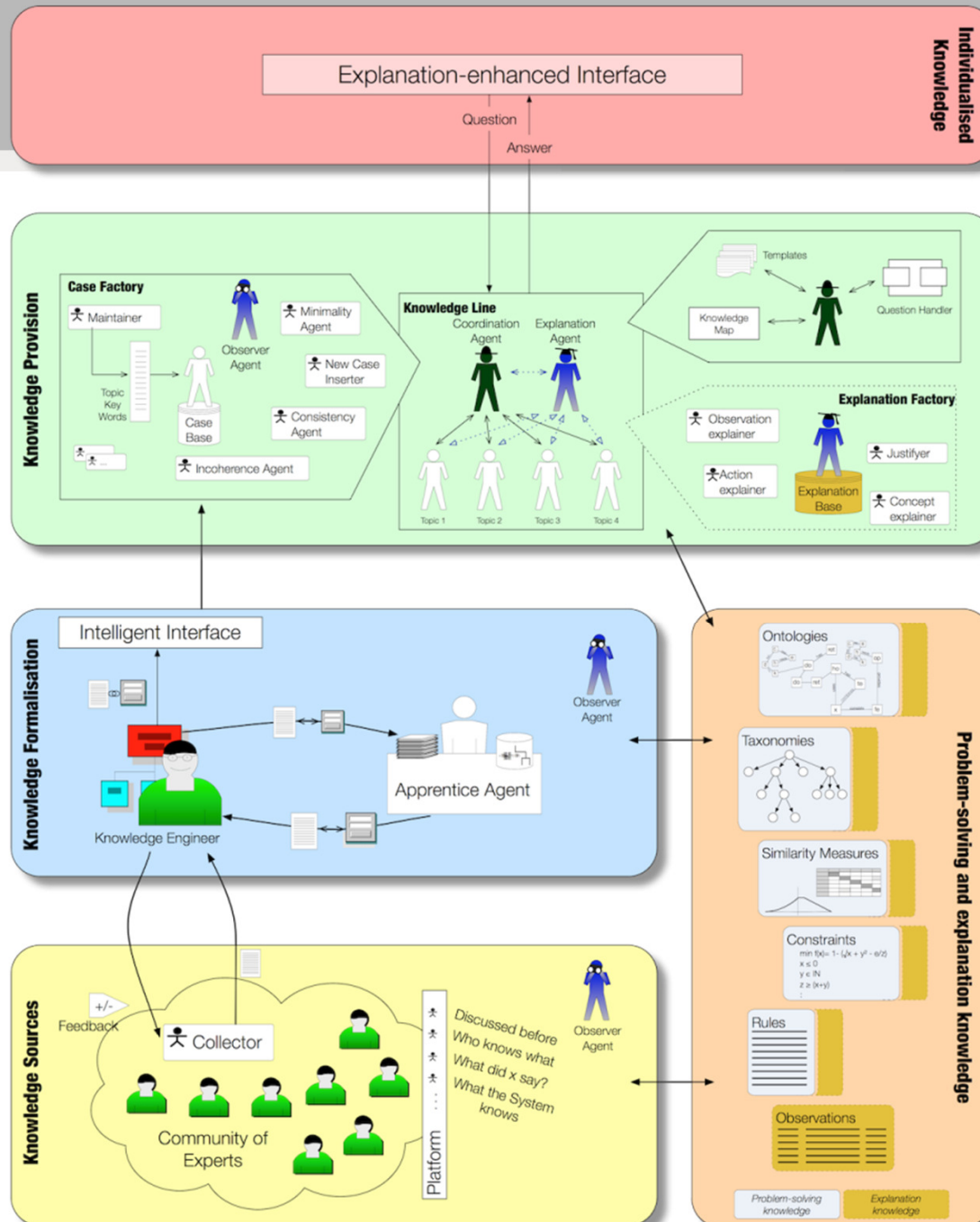
# Model-based and associative diagnostic reasoning using SEASALT agents



# CBR for life counselor support







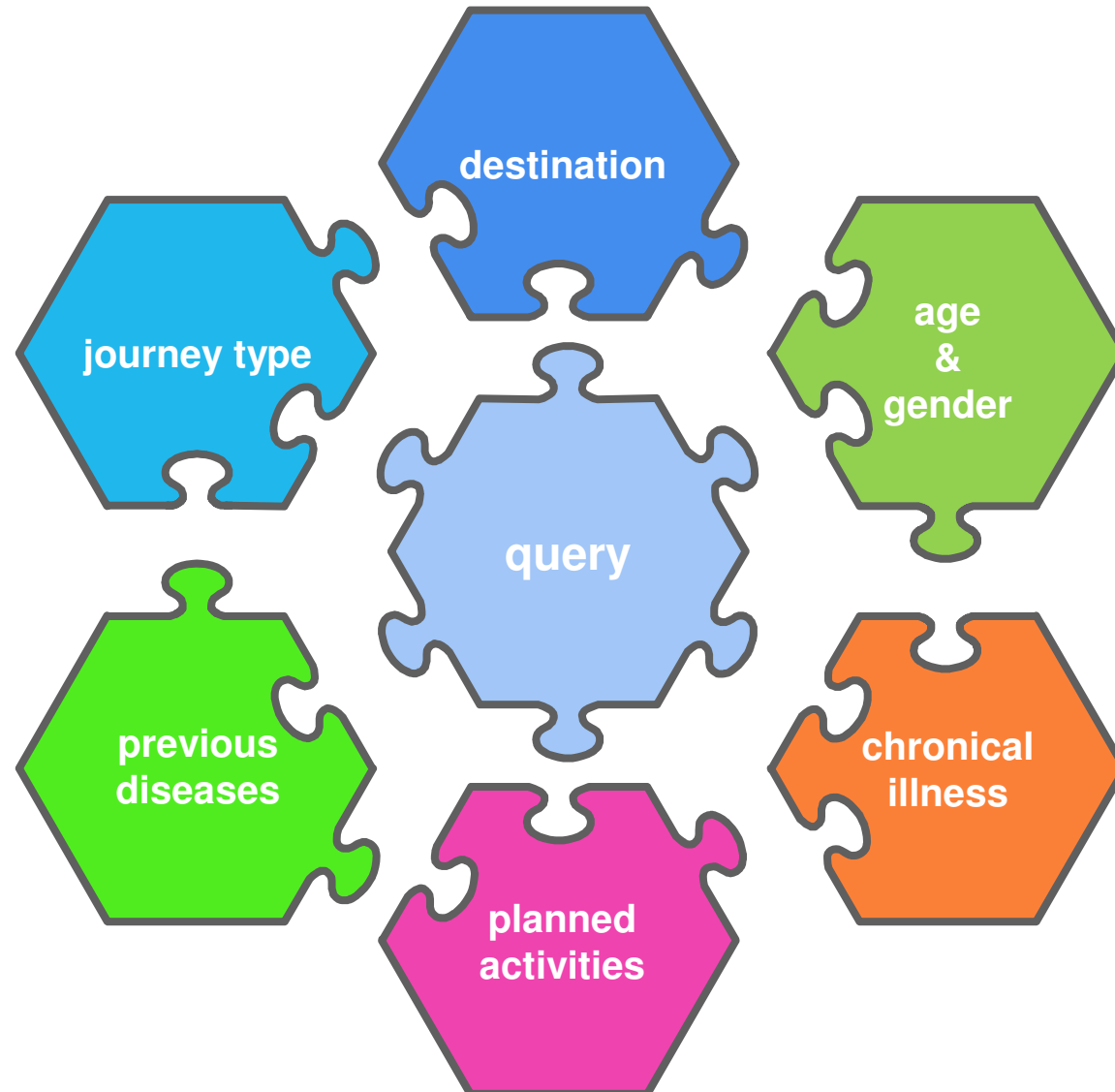
See also:  
 T. Roth-Berghofer, C. Sauer, K.-D. Althoff, K. Bach & R. Newo  
 SEASALTextp— An Explanation-aware Architecture for  
 Extracting and Case-Based Processing of Experiences  
 from Internet Communities  
 Proc. of the annual German Workshop on Knowledge and  
 Experience Management (FGWM 2011), Magdeburg, 2011.

- ▶ PhD thesis Kerstin Bach:
  - Knowledge Acquisition for Case-Based Reasoning Systems
- ▶ PhD research Régis Newo
  - Case-Based Reasoning for Life Counseling Support
- ▶ PhD research Pascal Reuss
  - Explanation-Aware Maintenance of Distributed Case-Based Reasoning Systems
  - See talk this morning
- ▶ SEASALT
  - Case study on technical diagnosis
- ▶ myCBR
  - Cooperation with University of West London (Th. Roth-Berghofer)
  - Crawling of Web based information sources for case acquisition and explanation ability support of Case-Based Reasoning systems

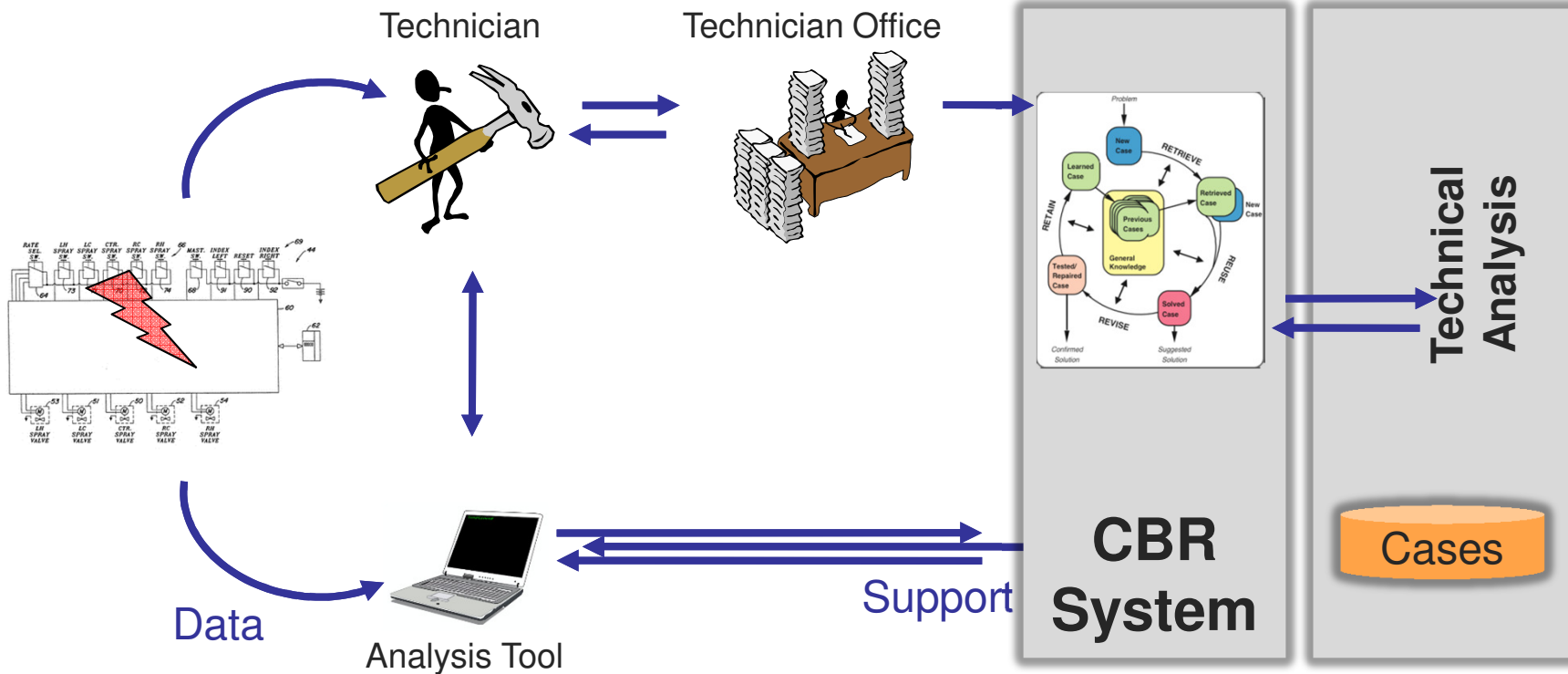
- ▶ Winner of CCC 2009
- ▶ Winner of community vote 2010
- ▶ Winner of menu challenge 2008
- ▶ Participant in CCC demos 2011
- ▶ Participant in CCC competition 2012
- ▶ CookIIS on myCBR
- ▶ CookIIS via Android app



# docQuery: The travel medicine application



# Providing machine diagnosis from service reports



- ▶ PhD thesis Kerstin Bach:
  - Knowledge Acquisition for Case-Based Reasoning Systems
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Thank you for your attention!  
Questions?

