



# Collaborative Multi-Expert-Systems



Klaus-Dieter Althoff

Competence Centre  
Case-Based Reasoning (CCCBR)  
German Research Centre for  
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Intelligent Information Systems Lab  
Institute of Computer Science  
University of Hildesheim  
Hildesheim, Germany

## The DFKI research labs



**Saarbrücken**



**Kaiserslautern**



**Bremen**

Intelligent  
User Interfaces  
Prof. Wahlster

Knowledge  
Management  
Prof. Dengel

Robotics  
Prof. Kirchner

Language Technology  
Prof. Uszkoreit

Augmented Vision  
Prof. Stricker

Cyber-Physical  
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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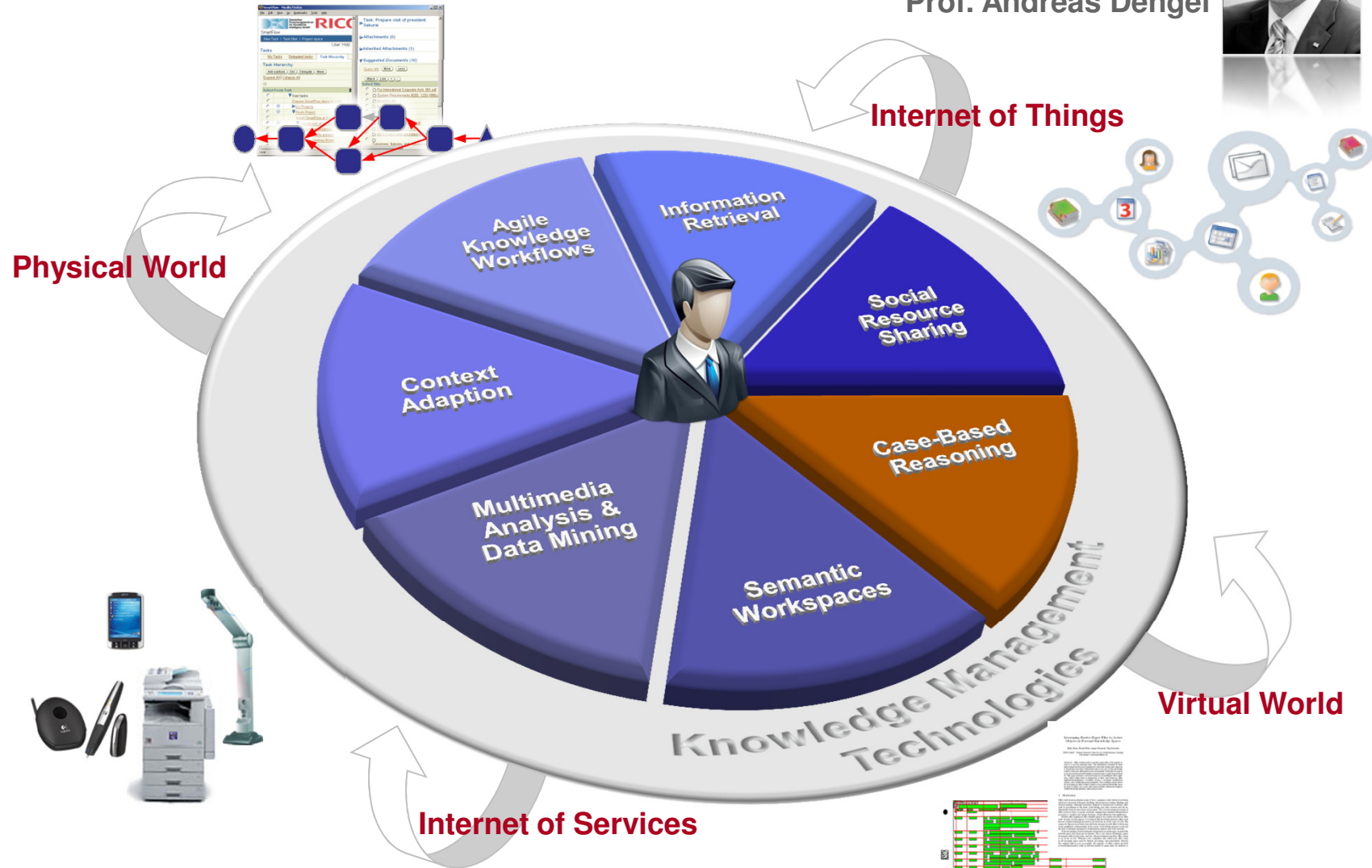
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# The Knowledge Management Department aims at the technological support of knowledge workers

Prof. Andreas Dengel



## Competence Centre **Case-Based Reasoning**

- **Founded in May 2010**
  - Collaboration contract with University of Hildesheim
- **Currently 2 Senior Researchers, 2 Researchers, further PhD students and student assistants**
- **Current projects**
  - Travel medicine
  - Computer cooking / nutrition
  - Life counseling
  - Simulating solving of critical problems
- **Former projects on diagnostics, decision support, experience management, customer support / help desk**
  - VW Financial Services, John Deere, Telekom, Dresdner Bank, Allianz, Daimler, SMEs



# Collaborative Multi-Expert-Systems

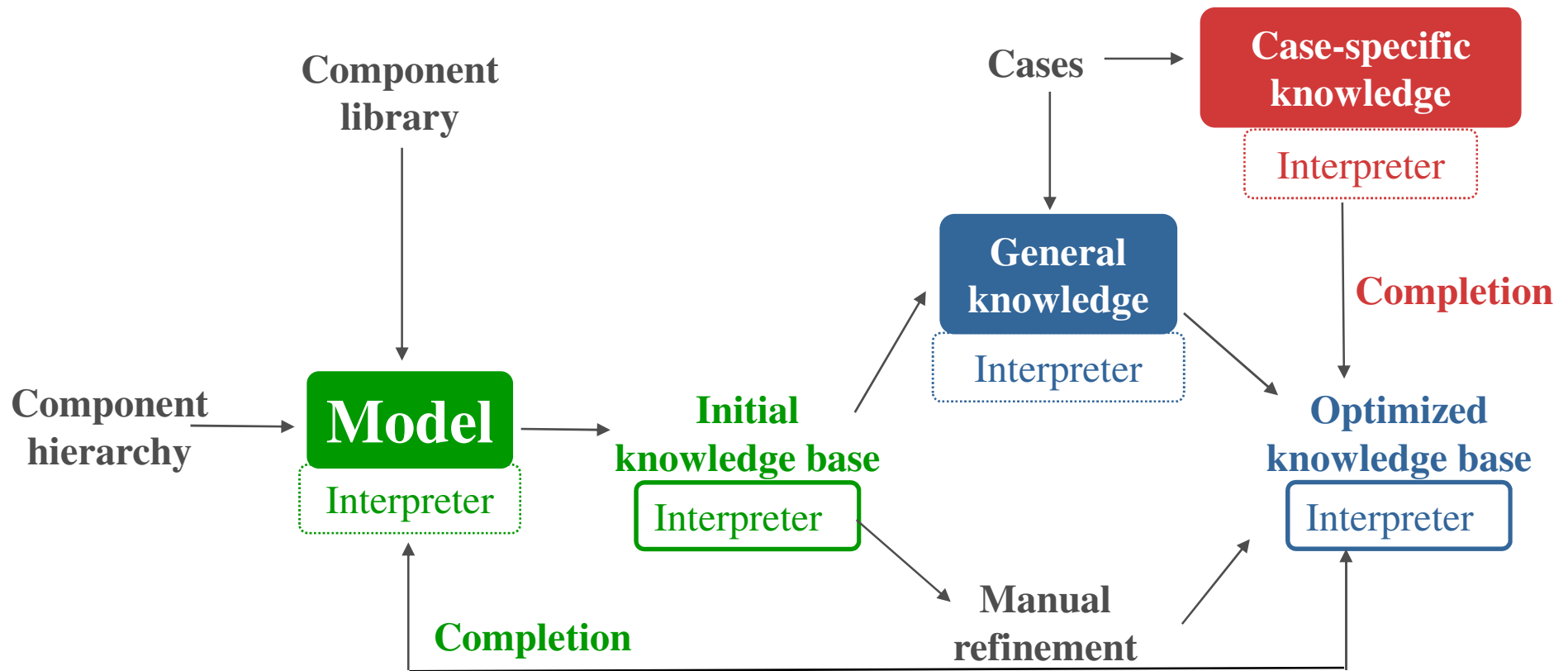


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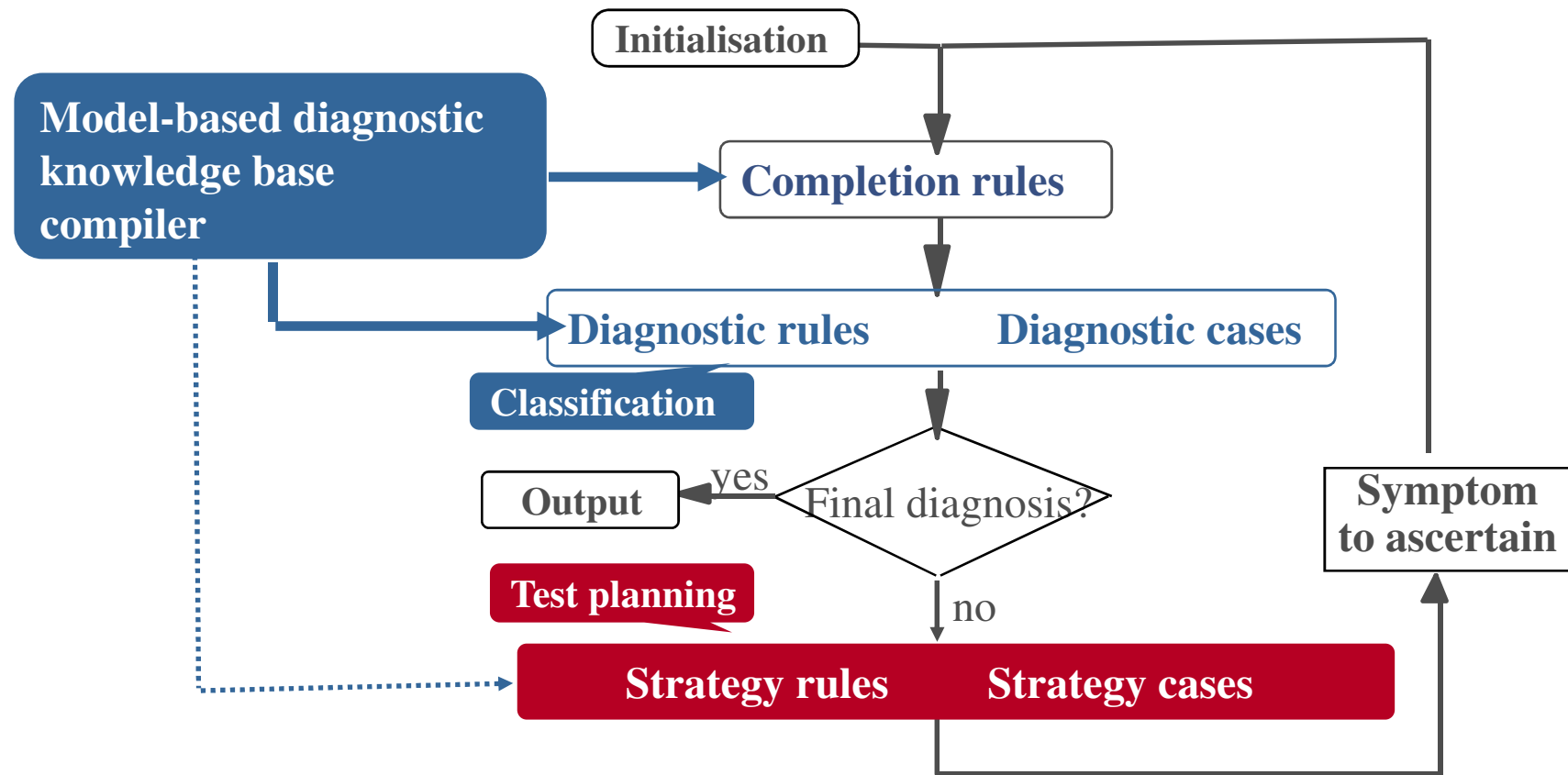
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# Integrated model-based, associative diagnostic system



# Integrating model-based and associative diagnostic reasoning





## Optimal Support for knowledge work(ers)

- Increasing importance of knowledge as a production factor
  - Knowledge-intensive services
  - Knowledge work(ers)
- Ambient Intelligence scenarios
  - Intelligent workplace
  - Ambient campus
- **Developing** intelligent information systems for supporting
  - Knowledge-intensive services and
  - Knowledge work
    - with the specific use of **experience**
  - Intelligent information systems contain knowledge that is knowledge for both the user AND the computer
    - For this presentation we view intelligent information systems as **knowledge-based systems** (expert systems)

- **Knowledge-intensive services**
  - need the resource knowledge as their most important input factor when delivered
- **Knowledge-intensive work**
  - includes activities that require an intensive education and experience on a specific subject that has been accumulated over many years
- **Knowledge work**
  - denotes activities where the problem solving process is based not only on once acquired but on constantly revised, improved and updated knowledge
- **Experience**
  - represents the success-critical knowledge for knowledge-intensive services and knowledge work

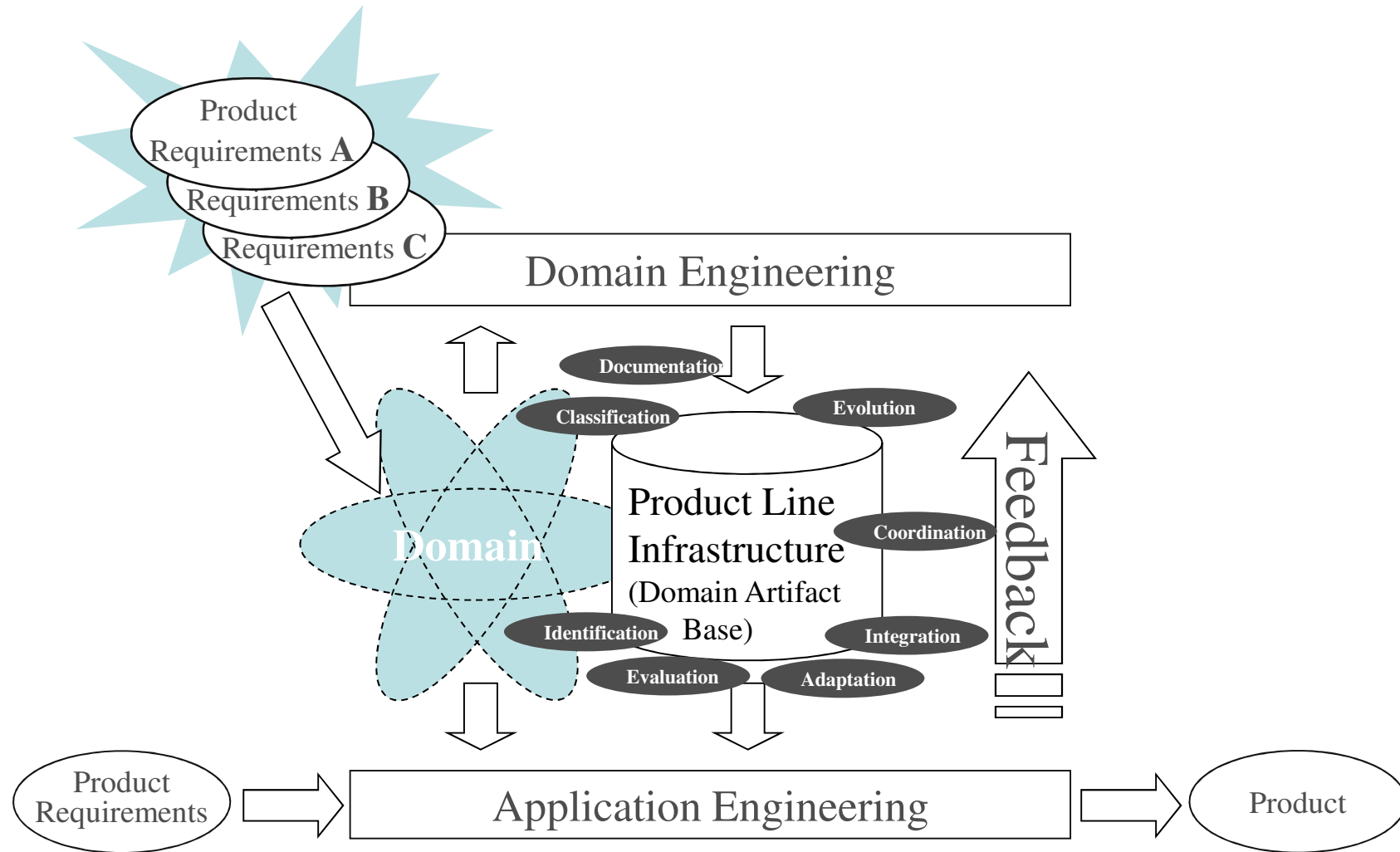
# Requirements for intelligent information systems

- Smart support
- Intelligent behavior
- **Learning from experience**
  - Improvement of system behavior
- More flexibility
  - **Easily to build / reuse**
  - Easily to adapt
  - Easily to maintain
- **Decentralization**
  - Easily to integrate
  - Easily to use

Idea: **Knowledge Product Line**

- Our approach considers **distributed learning systems** as a model for future intelligent software systems
- A knowledge product-line (short: **knowledge line**) denotes the systematic application of the **software product line** approach to the knowledge of an intelligent information system
- Knowledge lines allow to introduce the necessary modularization for constructing potential variants on the „**knowledge level**“
  - We adopt **multi-agent systems** as the basic modeling and design approach for the knowledge level

# Software Product Lines



- A computer program is called **software agent** if it intends to have the following characteristics:
  - autonomous
  - preactive
  - reactive
  - social
  - **learning**
- **Intelligent agents** have access to knowledge and are able to learn, to reason, and to change their behavior.
- A **multi-agent system** (MAS) solves problems based on a „team of (software) agents“ supplementing one another.

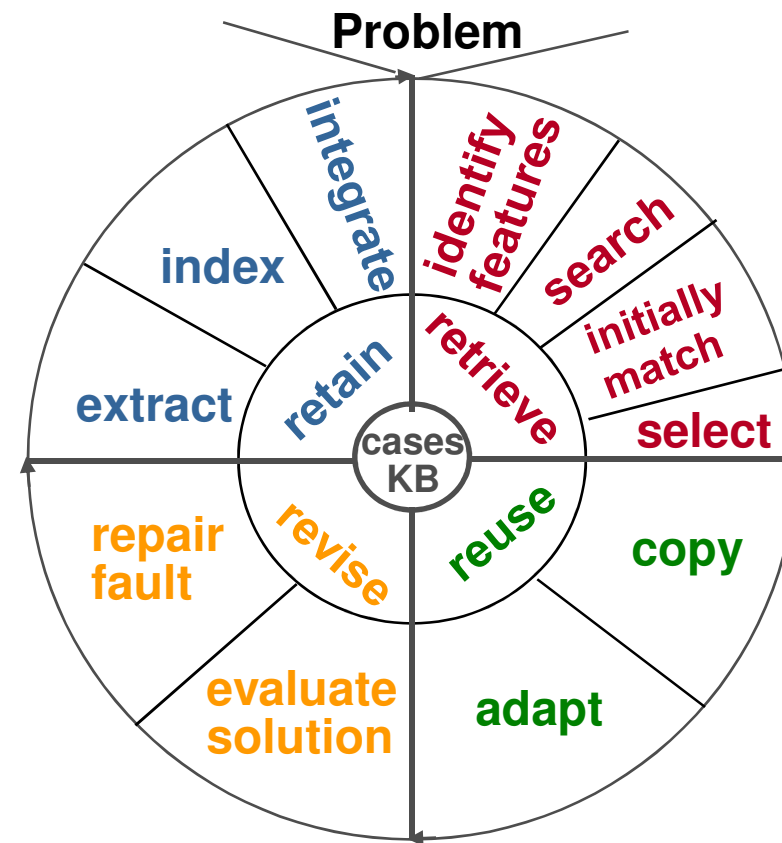
## Goals to achieve with MAS

- Modularity
- Decentrality
  - Improved resource usage
  - Improved performance
- Improved user involvement
- Improved fault tolerance
- Improved component reuse
- Dynamic reconfiguration during operation
- Self-organizing adaptation

# Case-Based Reasoning (CBR)

An approach to solve new problems by adapting solutions of similar past problems.

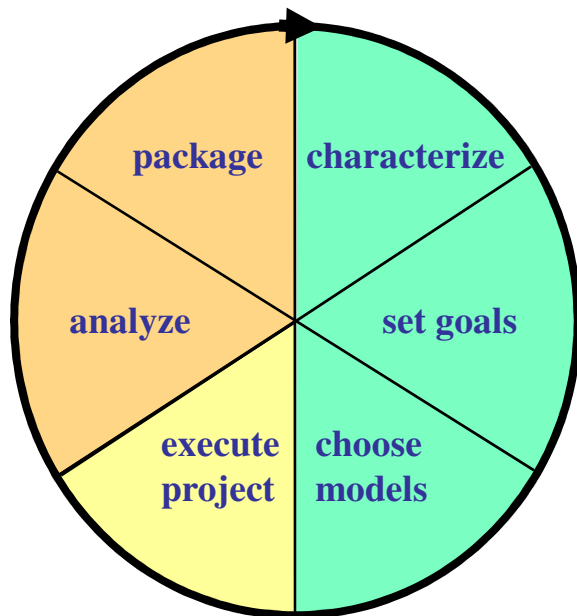
- Problem: **Initial problem description defines new case**
- Retrieve: **New case is used to find a similar case in the case base**
- Reuse: **Combination of new and retrieved case provides solved case**
- Revise: **Evaluation of the suggested solution**
- Retain: **Learning of useful experience through adapting the case base and/or the general domain knowledge**



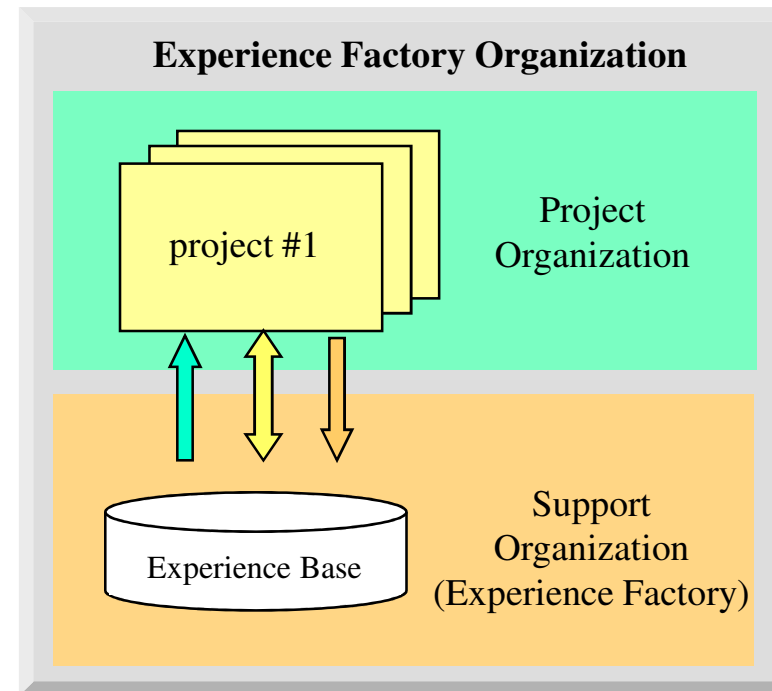


# Experience Factory and Quality Improvement Paradigm

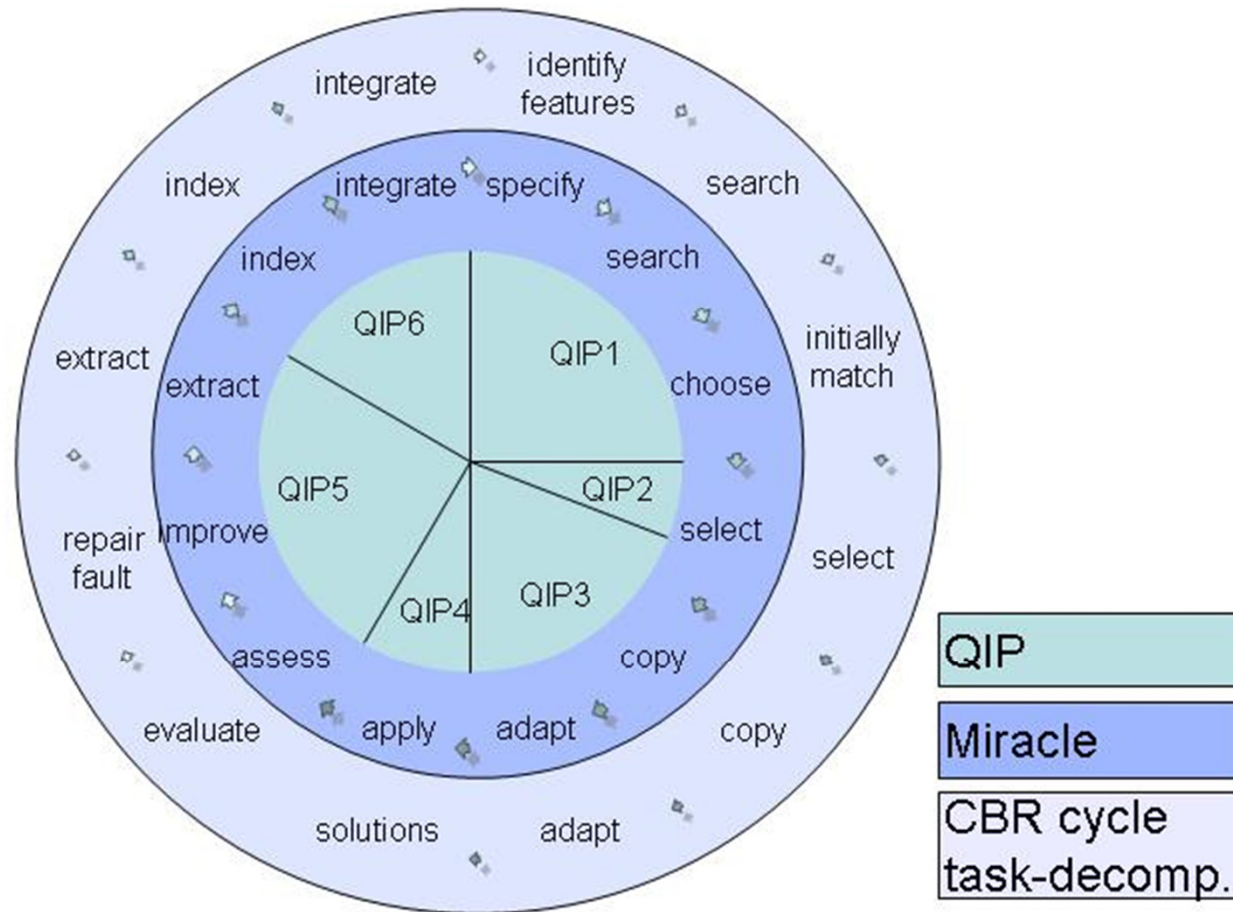
## Quality Improvement (QIP) Paradigm (Basili, Rombach, 1988)



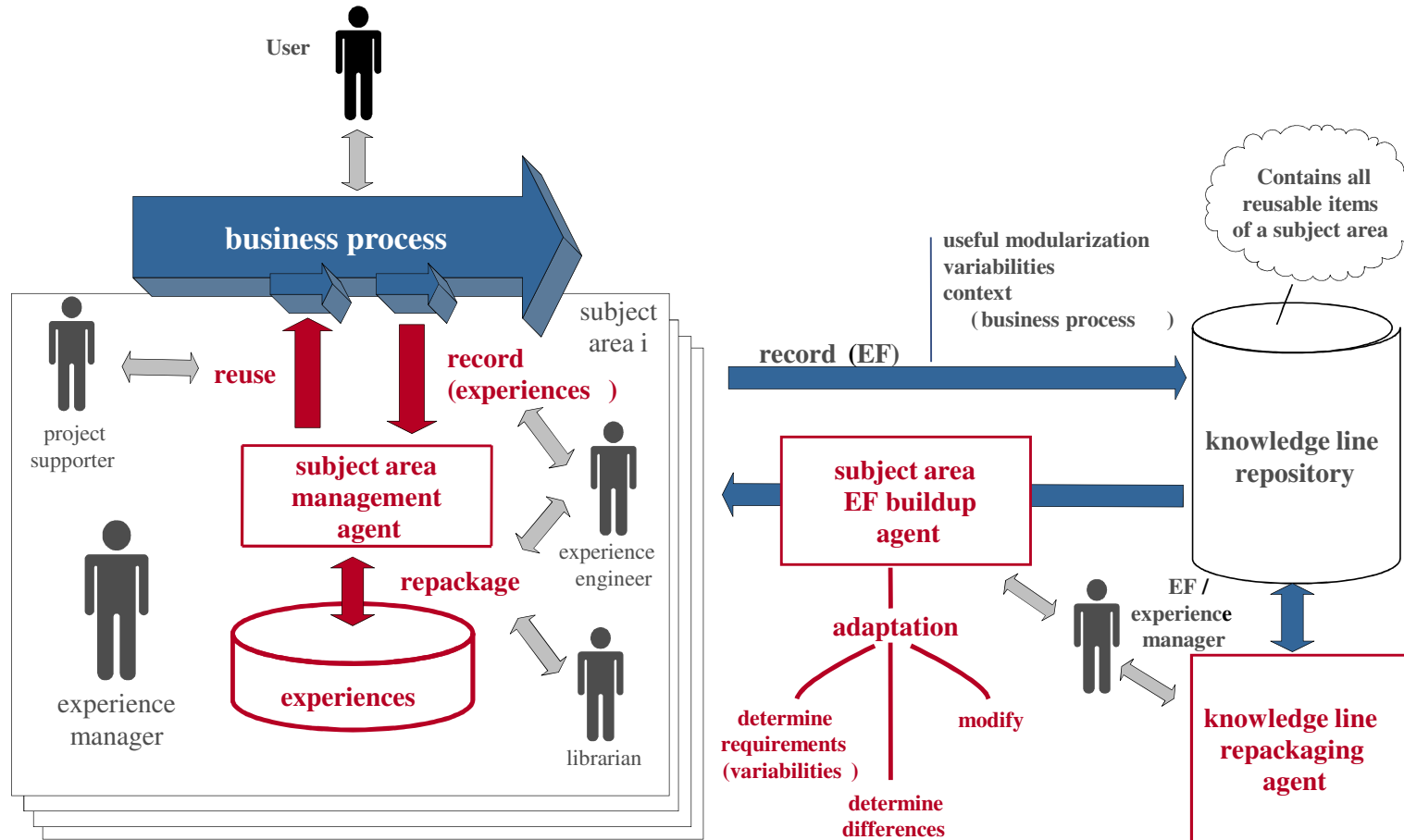
## Experience Factory (EF) Organization (Basili, Rombach, 1988)



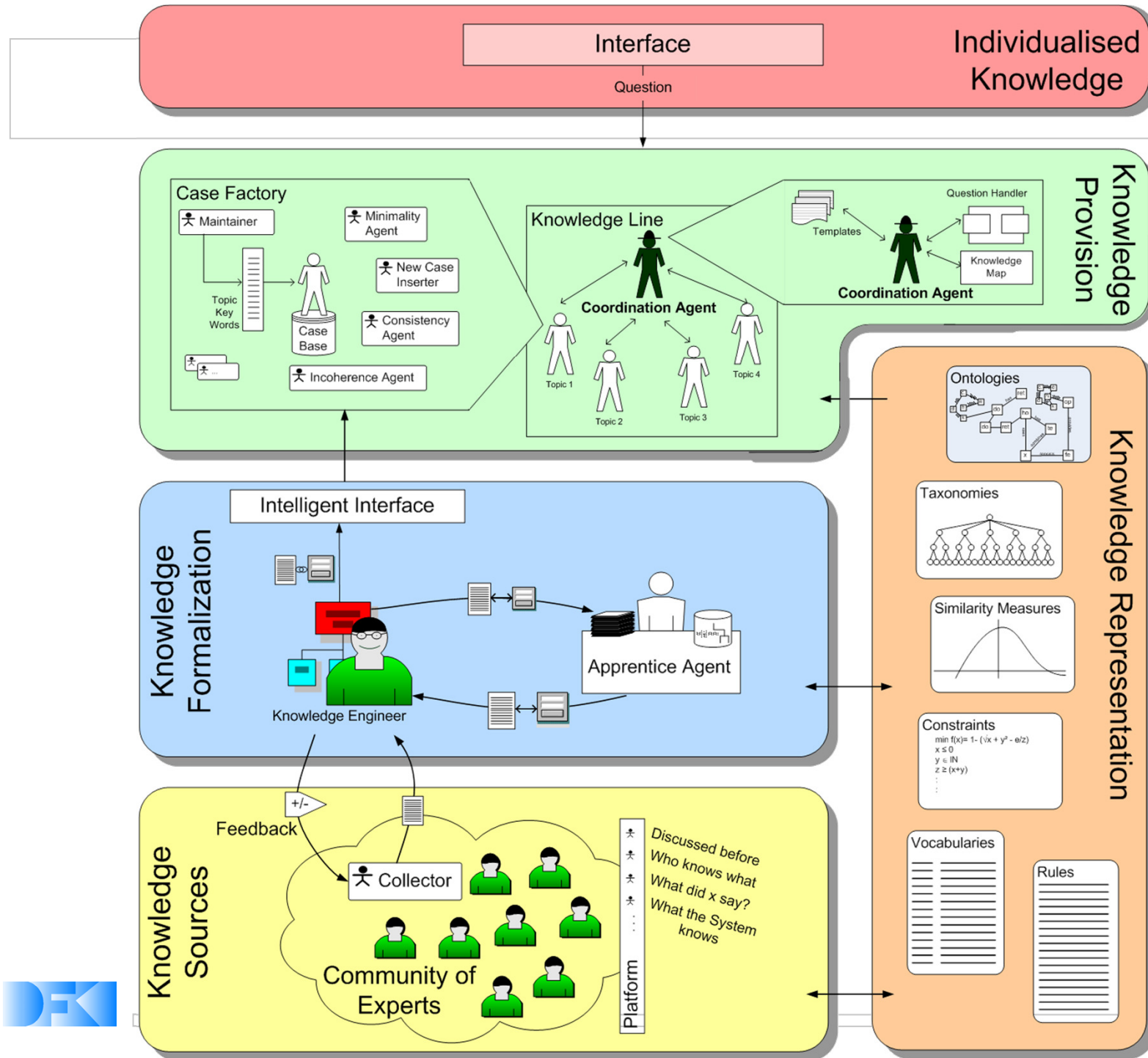
# Relating CBR and EF/QIP

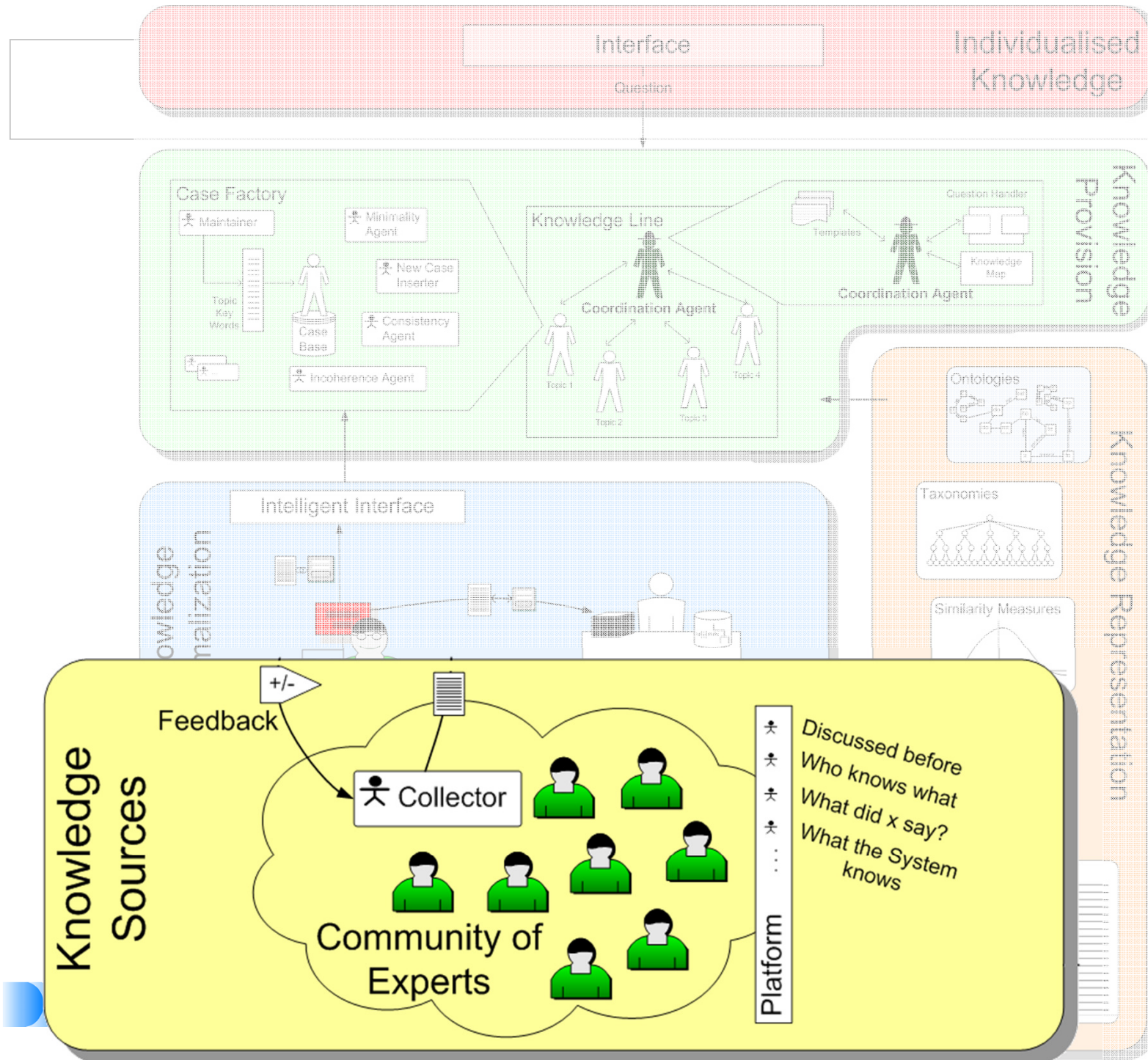


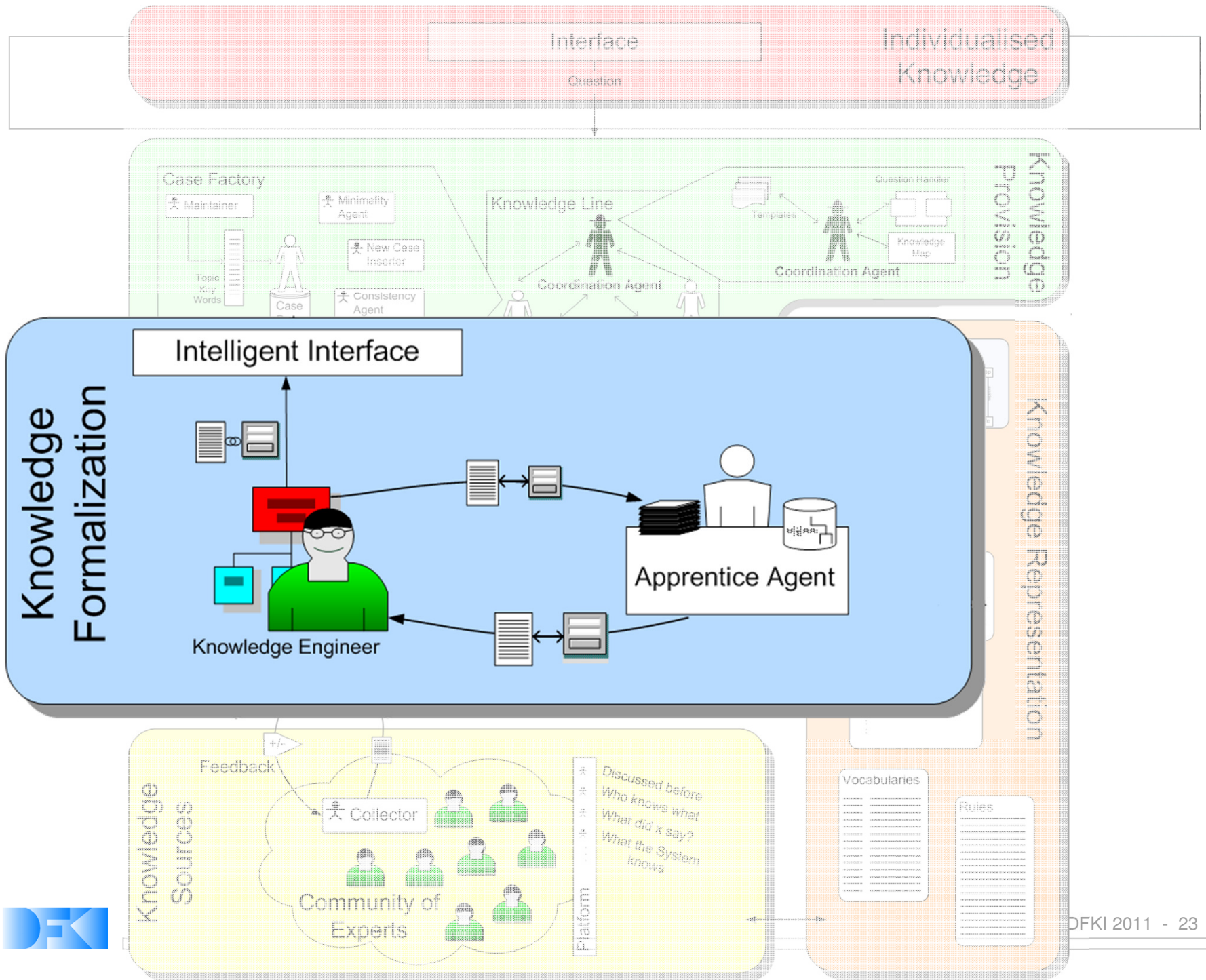
# Case Factory idea

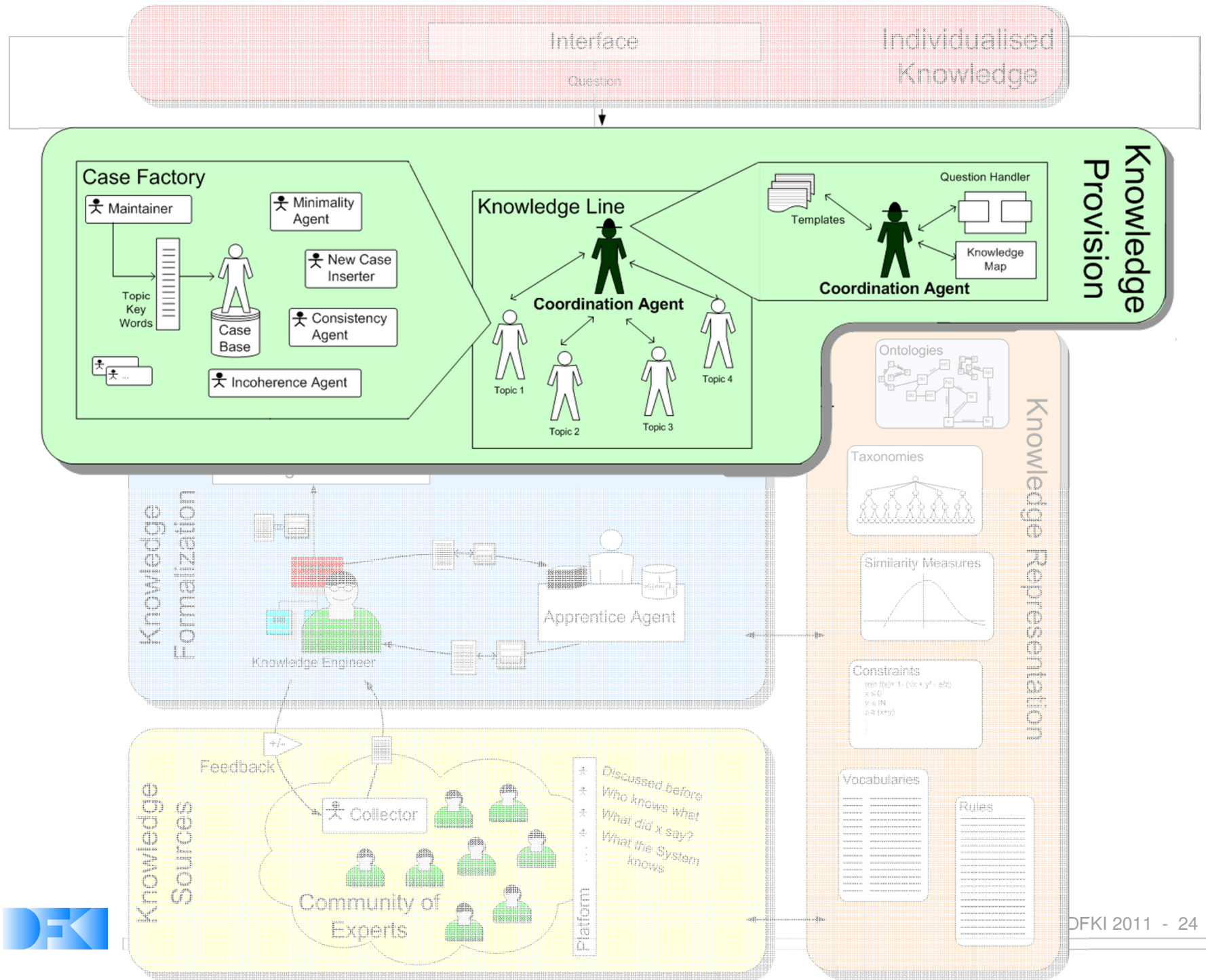


- Sharing Experiences using an Agent-based System Architecture Layout
- Instantiation of the CoMES (Collaborative Multi-Expert-Systems) approach
- Features
  - Application-independent architecture
  - Knowledge acquisition from a web-community
  - Knowledge modularisation and (re)composition
  - Agent-based knowledge maintenance

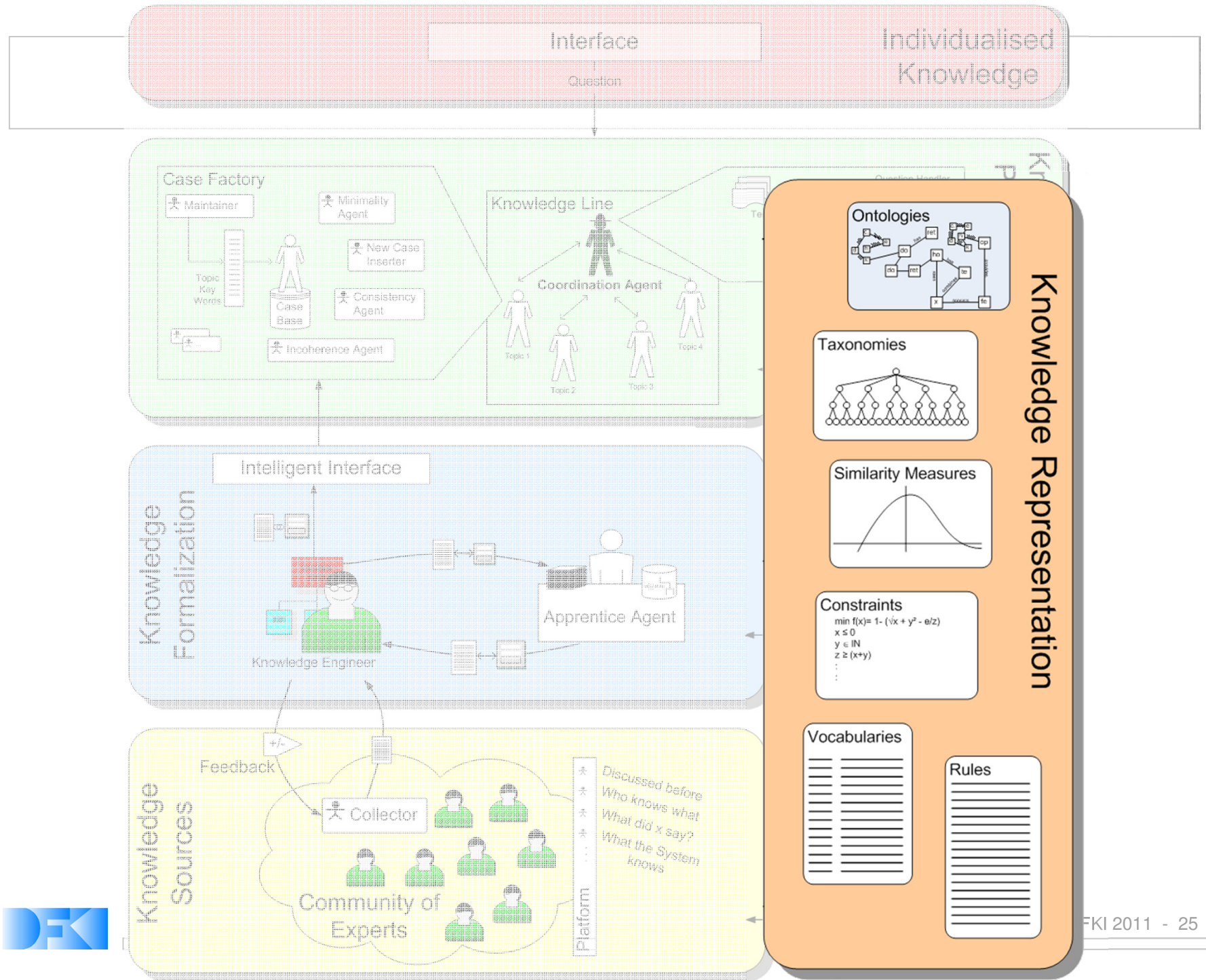


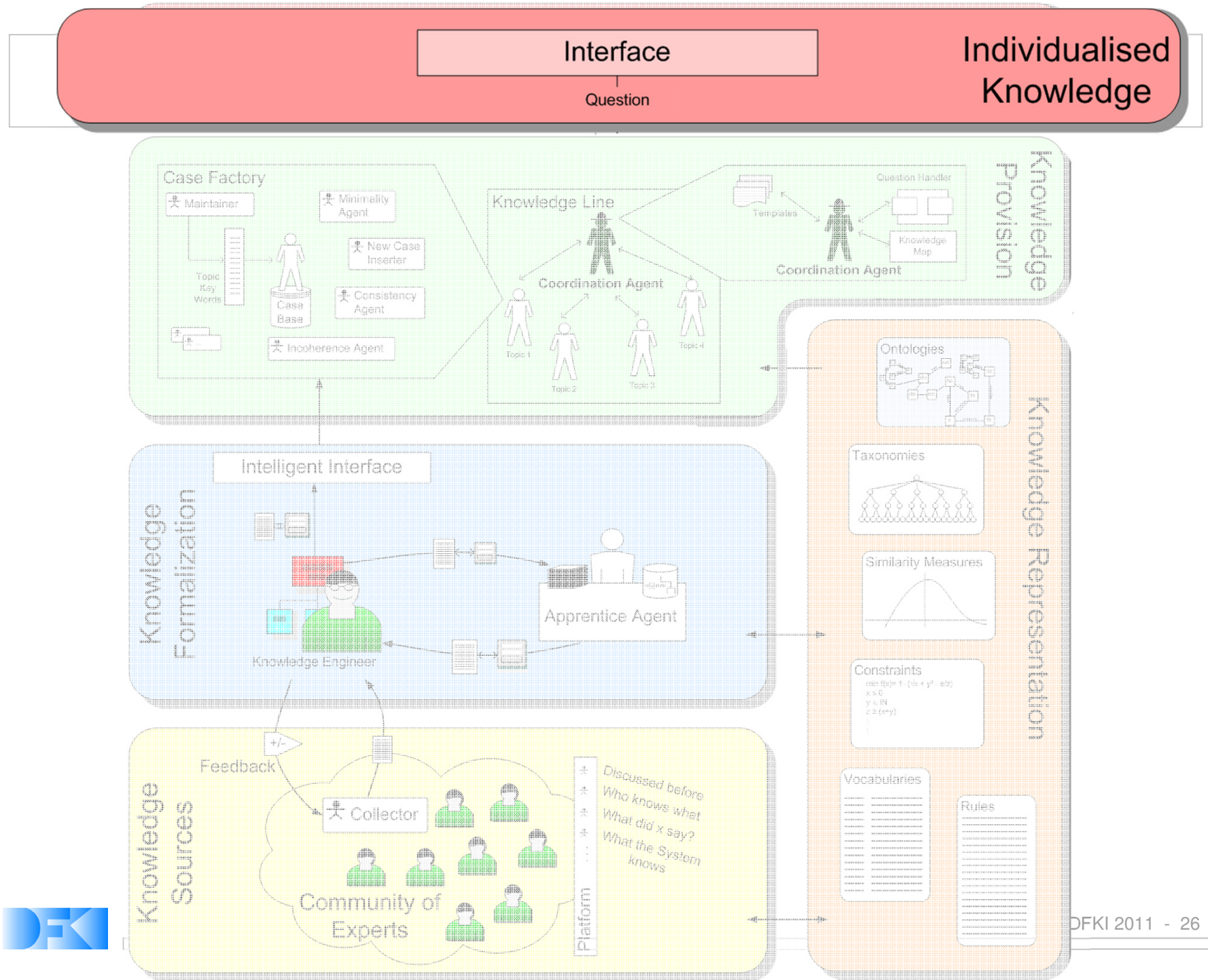












## Current Status (1)

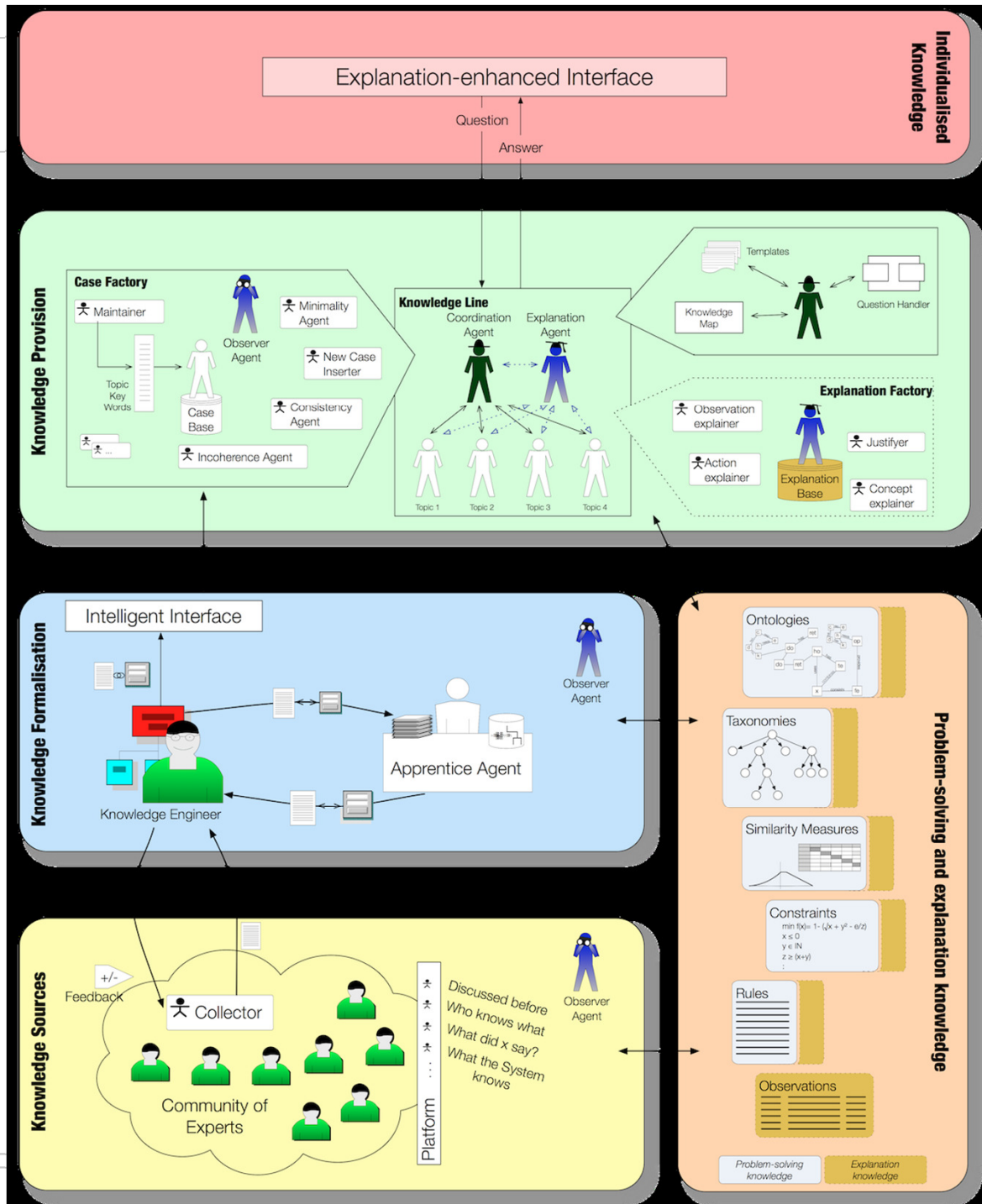
- Explanation-aware myCBR Development Project (REA)
  - Partner: University of West London (T. Roth-Berghofer / C. Sauer)
- docQuery
  - Partner: mediscon (Hannover, Germany)
- CookIIS
  - Transnet (Hannover, Germany)
- CBR for Life Counselor Support
  - Adelshofen Theological Seminary
    - Denominationally unaffiliated
    - Part of a network of educational institutions with relationship to life counselling
    - Cooperation with University of South Africa

## Current Status (2)

- myCBR
  - Further development
- Industrial cooperations
  - CBR for providing machine diagnosis from service reports
  - CBR for supporting bank employees while negotiating financial conditions with car dealers selling a car to their customer



# SEASALTExp



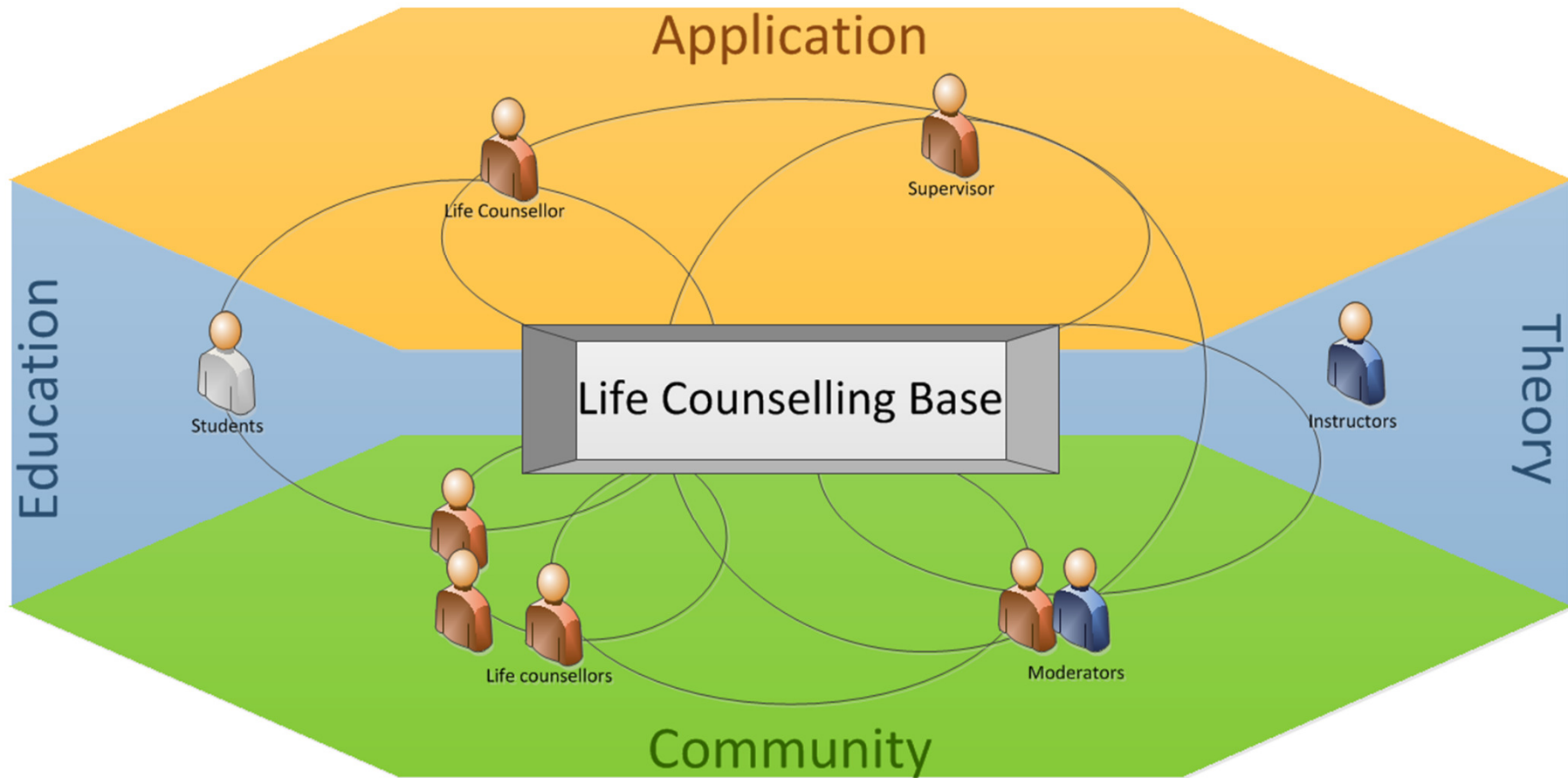
- **Travel Medicine**
  - Prevention, management and research of travel related medical aspects
  - Interdisciplinary: Requires expertise in other areas like geography, activities, etc.
- **Our main goal within the docQuery project**
  - Provision of individualized and reliable information
  - On-demand query processing
  - Up-to-date information

## CookIIS

- Winner of CCC 2009
- Winner of community vote 2010
- Winner of menu challenge 2008
- CookIS on myCBR
  - See later
- CookIIS via Android and iPhone app



# CBR for life counselor support

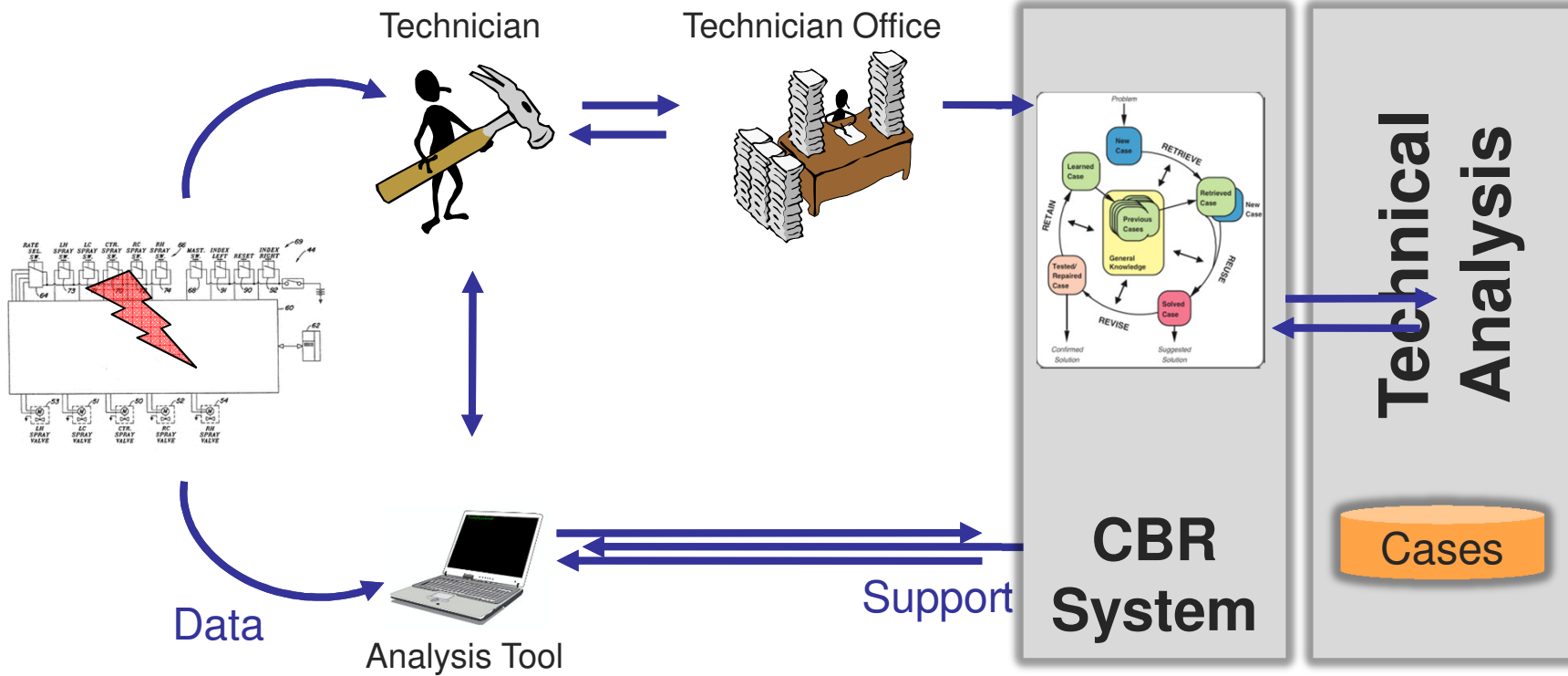


## myCBR Features

- Plug-in for popular ontology editor Protégé (Version 3.x)
- Stand-alone retrieval engine for separate use or integration with other systems
- Features provided by myCBR
  - Easy import of raw data (csv-files)
  - GUIs for modeling knowledge-intensive similarity measures
  - Similarity-based retrieval functionality
  - Export of domain model and similarity measures in XML format
- Built-in explanation capabilities
- For more information and download: <http://mycbr-project.net>

- myCamera
  - <http://cbrdemo.kl.dfki.de/myCamera>
- CookIIS
  - [http://cbrdemo.kl.dfki.de/CookIIS\\_Gruppe4](http://cbrdemo.kl.dfki.de/CookIIS_Gruppe4)
- PC configuration
  - <http://cbrdemo.kl.dfki.de/PCKonfig/configpage.jsp>
- myCookIIS
  - Integration of Drools

# Providing machine diagnosis from service reports



- Modeling expertise in its different facets
- Distributed CBR
  - Parallel CBR architectures
  - CBR and adhoc workflows
  - SEASALT
  - SEASALT<sup>exp</sup>
- Deep integration between CBR and explanation reasoning
- Automated knowledge extraction for CBR
- CBR for knowledge engineering and continuous formalization
  - CBR plus (other) semantic technologies
  - Nonstandard machine learning

## Outlook (2)

- Applying CBR in domains with high social interest
  - Life counseling
  - Nutrition
  - Health
  - Youth welfare services
- SME consulting support
- Cognitive simulation

Questions?

