

On Explanation

—Supporting the Use of Complex Information Systems—

Dr. Thomas Roth-Berghofer, Senior Researcher

German Research Center for Artificial Intelligence DFKI GmbH

Interner Workshop

November 23, 2007, Kaiserslautern, Germany

Current activities in several projects



Quotes from the symposium

- ✦ „Knowledge is something that can be used for answering certain questions.“ (Prof. Yingxi Zhong)
- ✦ „Systems must adapt to us humans.“, „We have to learn more about human systems.“, „People have different background, different velocity of learning, different preferences ...“ (Prof. Klaus Mainzer)
- ✦ „... human-computer interaction = human-human interaction ...“ (Prof. Elisabeth André)

Quotes from Nepomuk prototype usability evaluation results

- ✦ ...
- ✦ The users want to know **why** things happen; „Why does the computer show me this document?“
- ✦ They also want to **affect** what the computer does for them; „How can I tell the compute that I don't want ...“
- ✦ People like to **be in control** of what happens.
- ✦ ...

1991: Seminar on case-based reasoning

First contact with „Case-based explanations“ and David B. Leake's work

Co-Chair of
Explanation-aware
Computing
workshops

Chapter 1

Fallbasiertes Erklären

Thomas Berghofer

Übersicht

Erklärungsbasiertes Lernen (explanation-based learning, kurz EBL) ist eine mächtige Methode zur Einordnung von Information. Da die zugehörigen Algorithmen auf gute Erklärungen angewiesen sind, müssen diese auf effiziente Weise konstruiert werden. Erst recht wenn diese auf die reale Welt Bezug nehmen, in der vollständige und genaue Informationen selten verfügbar bzw. möglich sind.

Menschen versuchen sich in neuen Situationen an bereits Erlebtem zu orientieren. Dies ist der Kernpunkt dieses Ansatzes.

Neue Erklärungen aus alten aufzubauen hängt vollkommen davon ab, daß bereits Erklärungen im Speicher verfügbar sind. Zur Beschreibung von Erklärungen werden explanation patterns eingeführt. Als Beispiel für eine Implementierung dient das System SWALE.

1997: Diploma thesis

„Explanation-based
learning of control
information from failures
in (action) planning“

Diplomarbeit

Erklärungsbasiertes Lernen
von Kontrollinformationen
aus Fehlschlägen bei der Planung

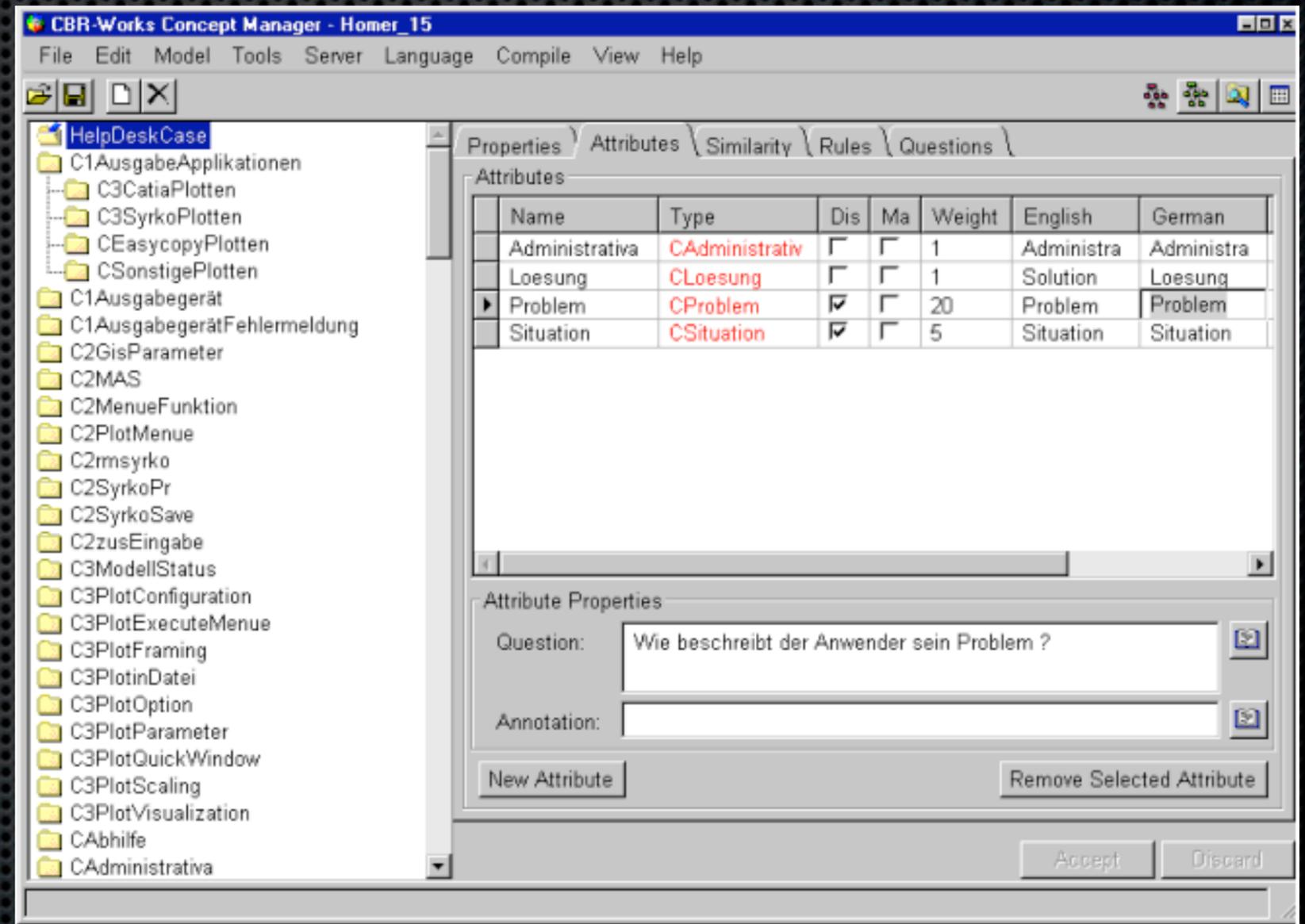
Thomas Roth-Berghofer

Juli 1996

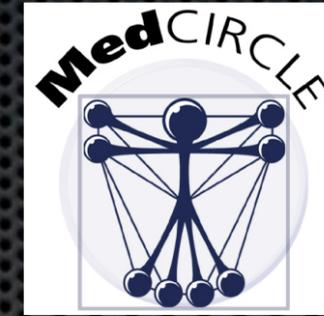
1997–2002: CBRWorks and orenge

Simple explanations of
similarity calculations
in *CBRWorks*

Explanation of
recognized concepts
in textual CBR part of
orenge



2004: Explanation of confidence calculation



Confidence table - Microsoft Internet Explorer

Adresse <http://www.cfc-efc.ca/>

MedCIRCLE Search Info Confidence: 0,9,21,0

MedCIRCLE confidence table

Preference item	Importance	Comparison result
Feedback mechanism	!	Okay
Contact page	!	Not available
Registration required	!	Okay

[Back](#)

Fertig Internet

What do we do when we have
problems following a conversation?

Then we ...

- ✦ Ask about the concepts we do not understand
- ✦ Request justifications for some fact or line of argumentation
- ✦ Ask about functions or purposes of used concepts
- ✦ Ask about motivation of conversation partner or how a conclusion was reached
- ✦ Ask about our conversation partner's confidence in some fact or line of reasoning

When was the last time you
„asked“ an information system
such questions?



„Trust me. I know
what I am doing!“

Sledge Hammer



„Trust me. I know
what I am doing!“

Sledge Hammer



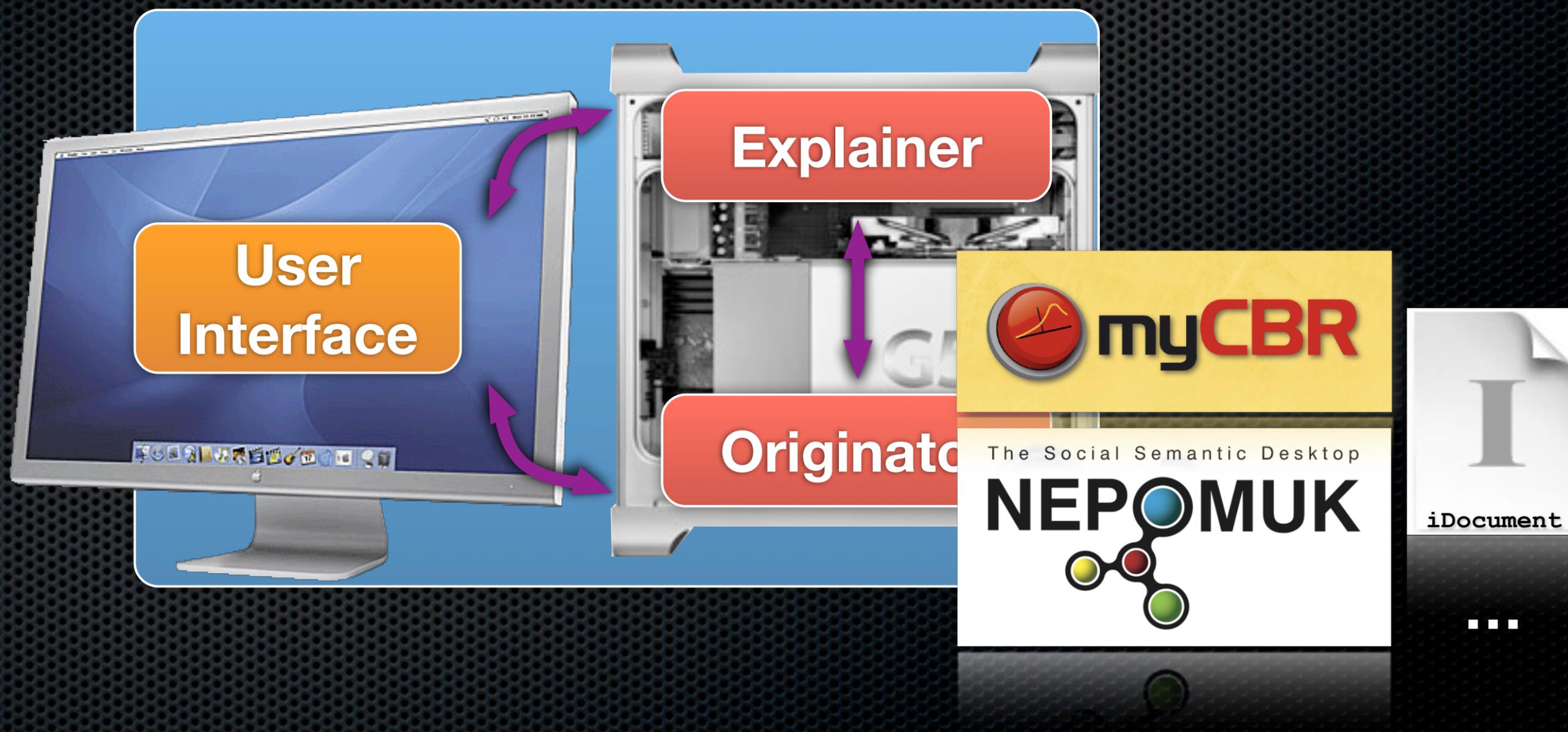
Explanation participants



Explanation participants

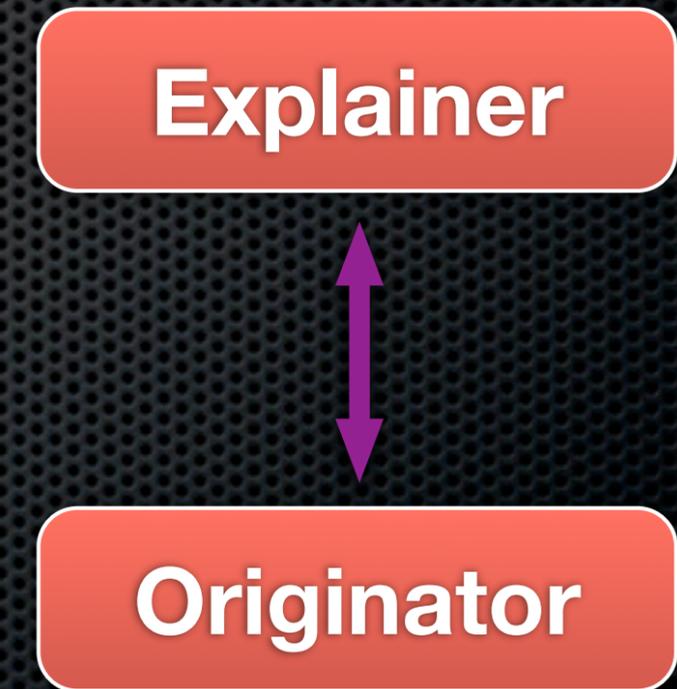


Explanation participants



Research questions

- ✦ Necessary knowledge
 - What does the explainer need to know for generating explanations?
 - What can and what does the originator need to provide?
- ✦ Explanation-enabled/-aware architecture
- ✦ Methodology
 - How to build an explanation-aware information system



Overview

- ✦ General explanation characteristics
- ✦ Explanations from an information point of view
- ✦ Example projects:

Nepomuk – The Social Semantic Desktop

myCBR

What are explanations?

What are explanations?

Explanations are answers to questions.

When are questions being asked?

When are questions being asked?

Whenever expectations are not met.

What must be explained?

Humans explain ...

- ✦ The **physical world**, i.e., how things work
- ✦ The **social world**, i.e., how societies work
- ✦ **Individual patterns** of behaviour, i.e., how individuals work



R. C. Schank. *Explanation Patterns: Understanding Mechanically and Creatively*.
Lawrence Erlbaum Associates, Hillsdale, NJ, 1986.

What are good explanations?

- ✦ Short and easy to overlook
- ✦ Innovative
- ✦ Relevant
- ✦ Convincing
- ✦ Different perspectives and follow-up questions
- ✦ Natural



W. R. Swartout and J. D. Moore. Explanation in second generation expert systems. In J. David, J. Krivine, and R. Simmons, editors, *Second Generation Expert Systems*, pages 543–585, Berlin, 1993. Springer Verlag.

What are good explanations?

- ✦ Short and easy to overlook
- ✦ Innovative
- ✦ Relevant
- ✦ Convincing
- ✦ Different perspectives and follow-up questions
- ✦ Natural

determined by
context-
dependent
criteria



W. R. Swartout and J. D. Moore. Explanation in second generation expert systems.
In J. David, J. Krivine, and R. Simmons, editors, *Second Generation Expert Systems*,
pages 543–585, Berlin, 1993. Springer Verlag.

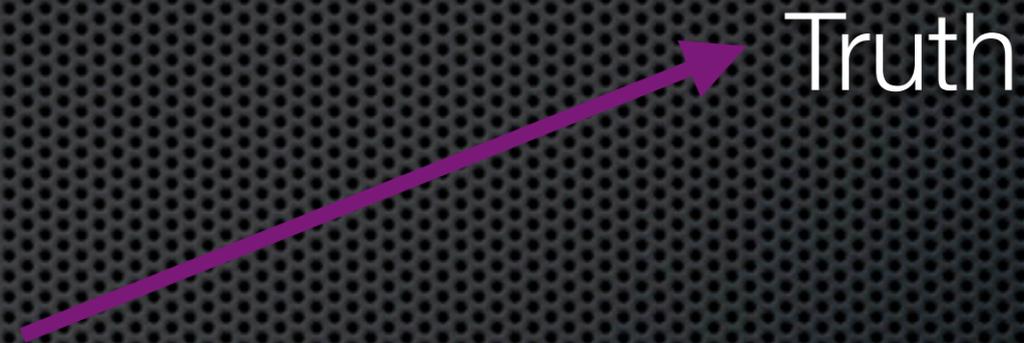
Explanations can be viewed as a kind of information.

Concepts connected with the notion of information

*„The train to Kaiserslautern
leaves Lugano at 13:55 h.“*

Concepts connected with the notion of information

*„The train to Kaiserslautern
leaves Lugano at 13:55 h.“*



Concepts connected with the notion of information

*„The train to Kaiserslautern
leaves Lugano at 13:55 h.“*



Truth

Understanding

Concepts connected with the notion of information

*„The train to Kaiserslautern
leaves Lugano at 13:55 h.“*



Truth

Understanding

Utility

Concepts connected with the notion of information

*„The train to Kaiserslautern
leaves Lugano at 13:55 h.“*



Truth

Understanding

Utility

Storage and
retrieval

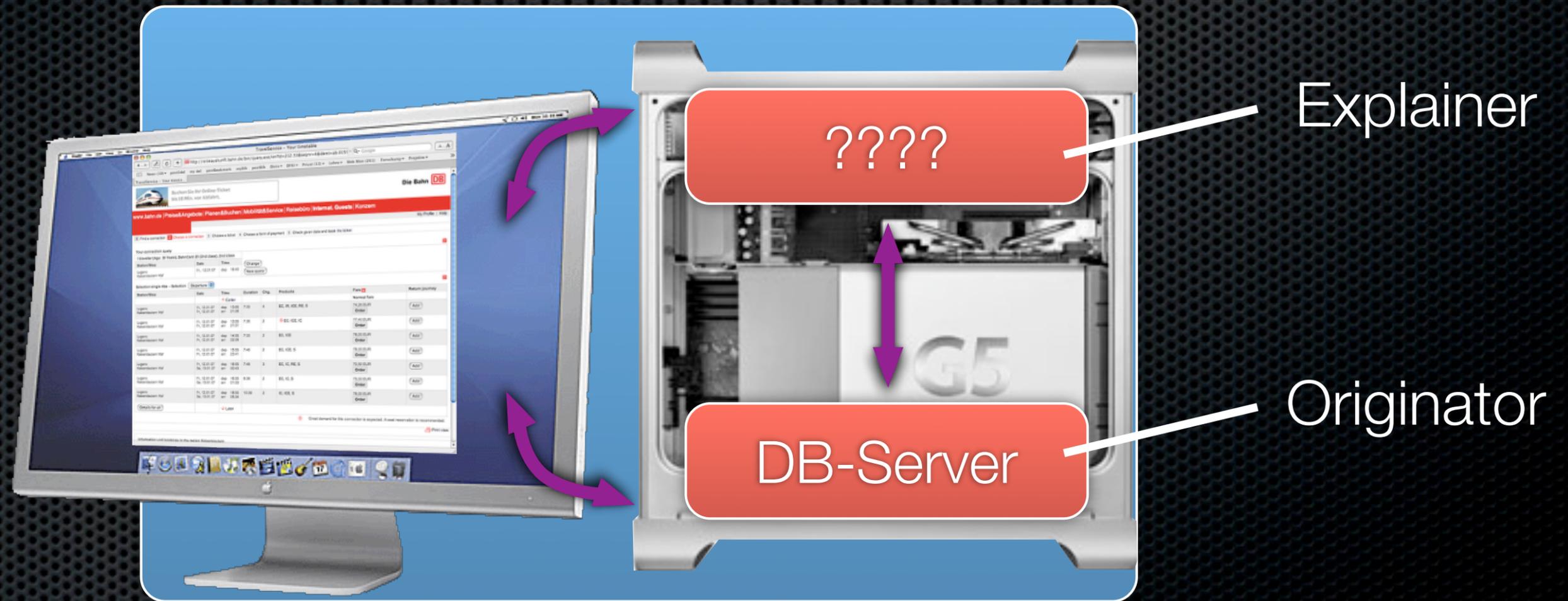
Concepts connected with the notion of information

*„The train to Kaiserslautern
leaves Lugano at 13:55 h.“*

Truth
Understanding
Utility
Storage and
retrieval
Information
generation



Participants in travel booking scenario



<http://www.db.de>

Participating bookings

TravelService - Your timetable

http://reiseauskunft.bahn.de/bin/query.exe/en?ld=212.53&seqnr=4&ident=ab.0155

Surf&Rail. Jede Woche 30 Top-Verbindungen ab 39,- EUR.

Die Bahn **DB**

www.bahn.de | Preise&Angebote | Planen&Buchen | Mobilität&Service | Reisebüro | Internat. Guests | Konzern

My Profile | Help

1 Find a connection 2 Choose a connection 3 Choose a ticket 4 Choose a form of payment 5 Check given data and book the ticket

Your connection query

1 traveller (Age: 39 Years), BahnCard 25 (2nd class), 2nd class

Station/Stop	Date	Time	Change
Lugano Kaiserslautern Hbf	Fr, 12.01.07	dep 16:40	<input type="button" value="Change"/>
			<input type="button" value="New query"/>

Selection single ride - Selection

Station/Stop	Date	Time	Duration	Chg.	Products	Fare i	Return journey
		↑ Earlier				Normal fare	
Lugano Kaiserslautern Hbf	Fr, 12.01.07 Fr, 12.01.07	dep 13:55 arr 21:28	7:33	4	EC, IR, ICE, RE, S	74,25 EUR <input type="button" value="Order"/>	<input type="button" value="Add"/>
Lugano Kaiserslautern Hbf	Fr, 12.01.07 Fr, 12.01.07	dep 13:55 arr 21:31	7:36	2	Ⓡ EC, ICE, IC	77,40 EUR <input type="button" value="Order"/>	<input type="button" value="Add"/>
Lugano Kaiserslautern Hbf	Fr, 12.01.07 Fr, 12.01.07	dep 14:55 arr 22:28	7:33	2	EC, ICE	78,00 EUR <input type="button" value="Order"/>	<input type="button" value="Add"/>
Lugano Kaiserslautern Hbf	Fr, 12.01.07 Fr, 12.01.07	dep 16:55 arr 01:33	8:38	2	EC, IC, S	75,00 EUR <input type="button" value="Order"/>	<input type="button" value="Add"/>
Lugano Kaiserslautern Hbf	Fr, 12.01.07 Sa, 13.01.07	dep 18:55 arr 05:34	10:39	2	IC, ICE, S	78,00 EUR <input type="button" value="Order"/>	<input type="button" value="Add"/>

↓ Later

Ⓡ Great demand for this connection is expected. A seat reservation is recommended.

Information und bookings in the region Kaiserslautern

Explainer

Originator

Explanation dimensions

Cognitive aspects of explanations

- „Explanations are the most common method used by humans to support decision making.“ (Schank, 1986)
- Main purpose:
 - Explain a solution.
 - How was the solution derived?
 - How does a system work?
 - How to handle a system
 - Explain failures.

Cognitive aspects of explanations

- „Explanations are the most common method used by humans to support decision making.“ (Schank, 1986)

- Main purpose:

Explain a solution.

How was the solution derived?

How does a system work?

How to handle a system

Explain failures.

- ... **Nepomuk evaluation results**

- The users want to know **why** things happen; „Why does the computer show me this document?“

- They also want to **affect** what the computer does for them; „How can I tell the compute that I don't want ...“

- People like to **be in control** of what happens.

- ...

Computational aspects

- ✦ Backward explanations:

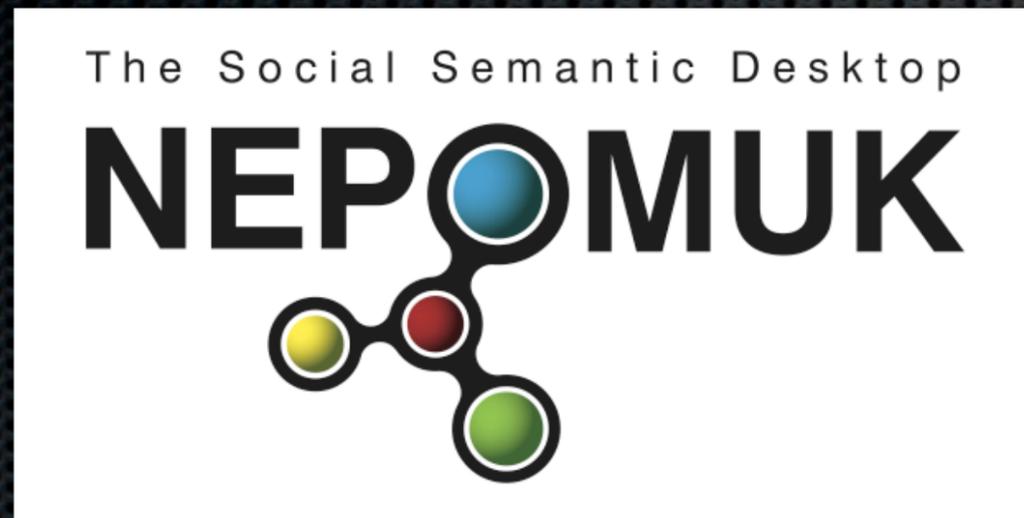
 - Explain the result and how it was obtained.

- ✦ Forward explanations:

 - Explain (indirectly) by showing different ways to further optimize a given result.

 - Open up possibilities for exploratory use.

Example

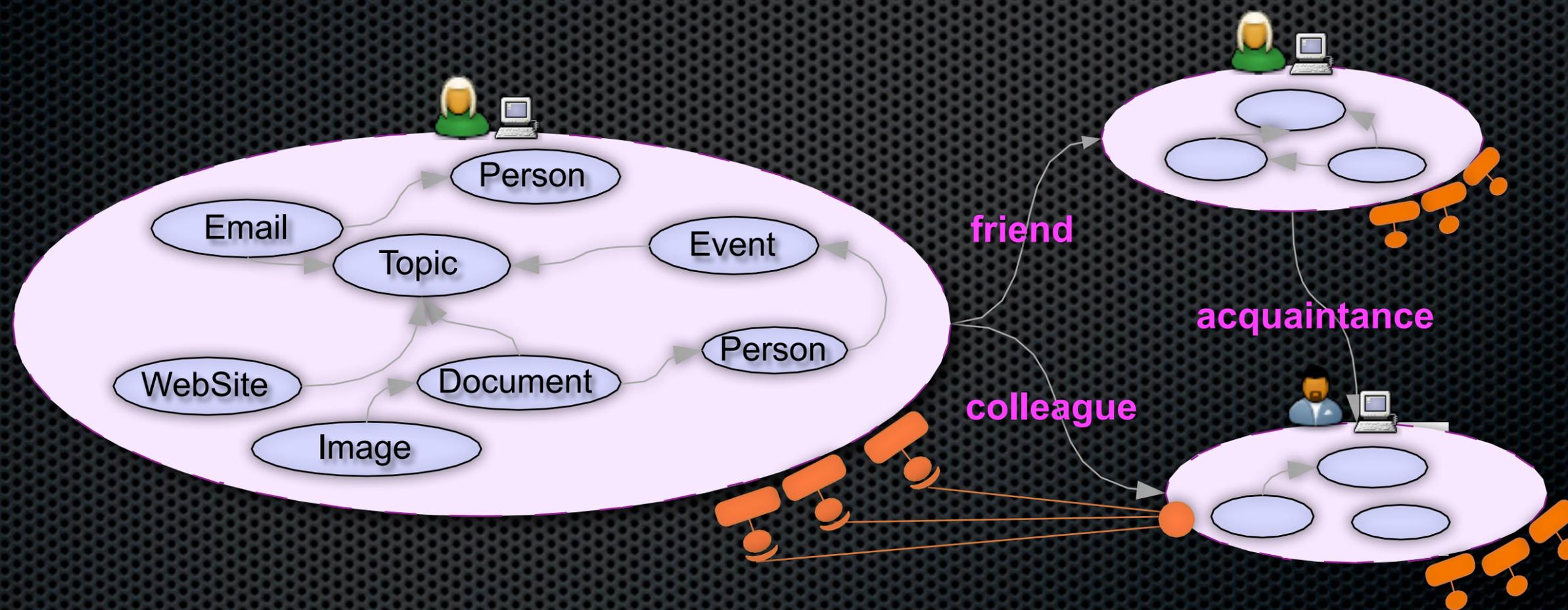


Backward
explanations



Forward and backward
explanations

NEPOMUK Vision

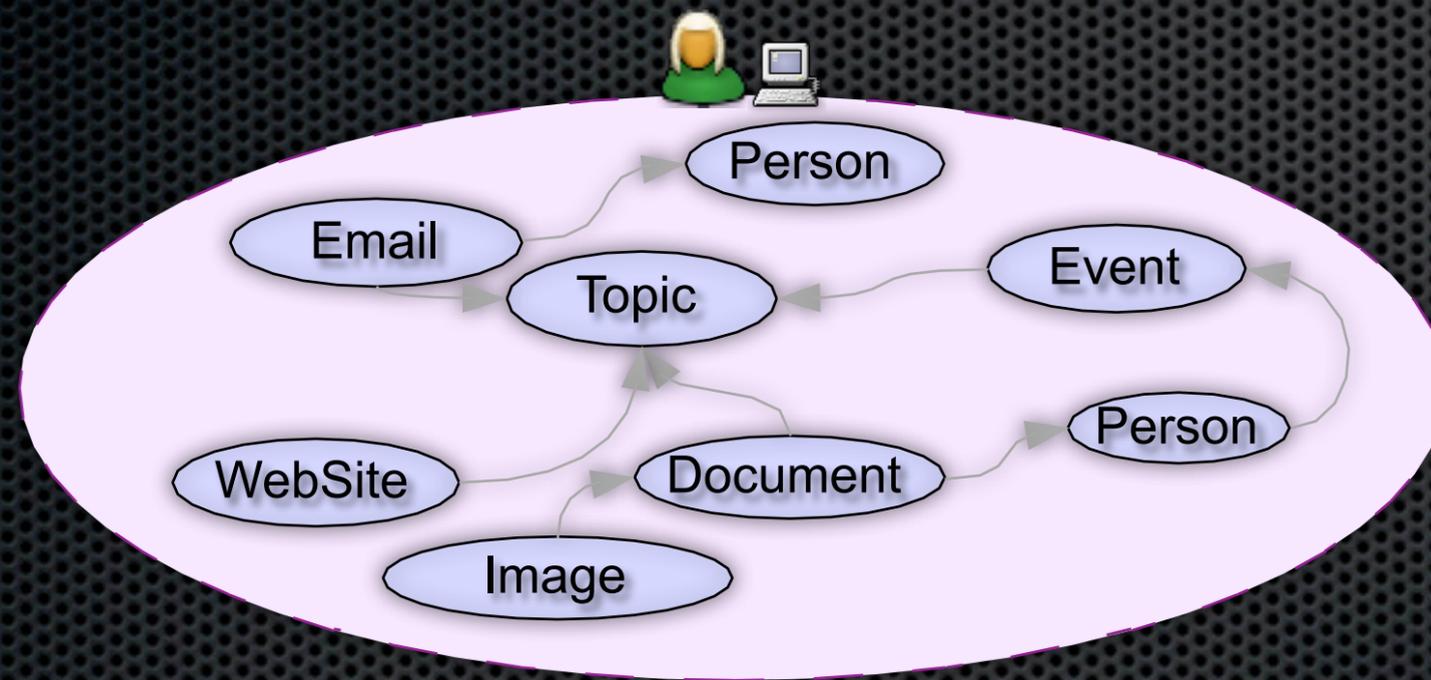


Personal Semantic Web: *a semantically enlarged intimate supplement to memory*

Social protocols and distributed search

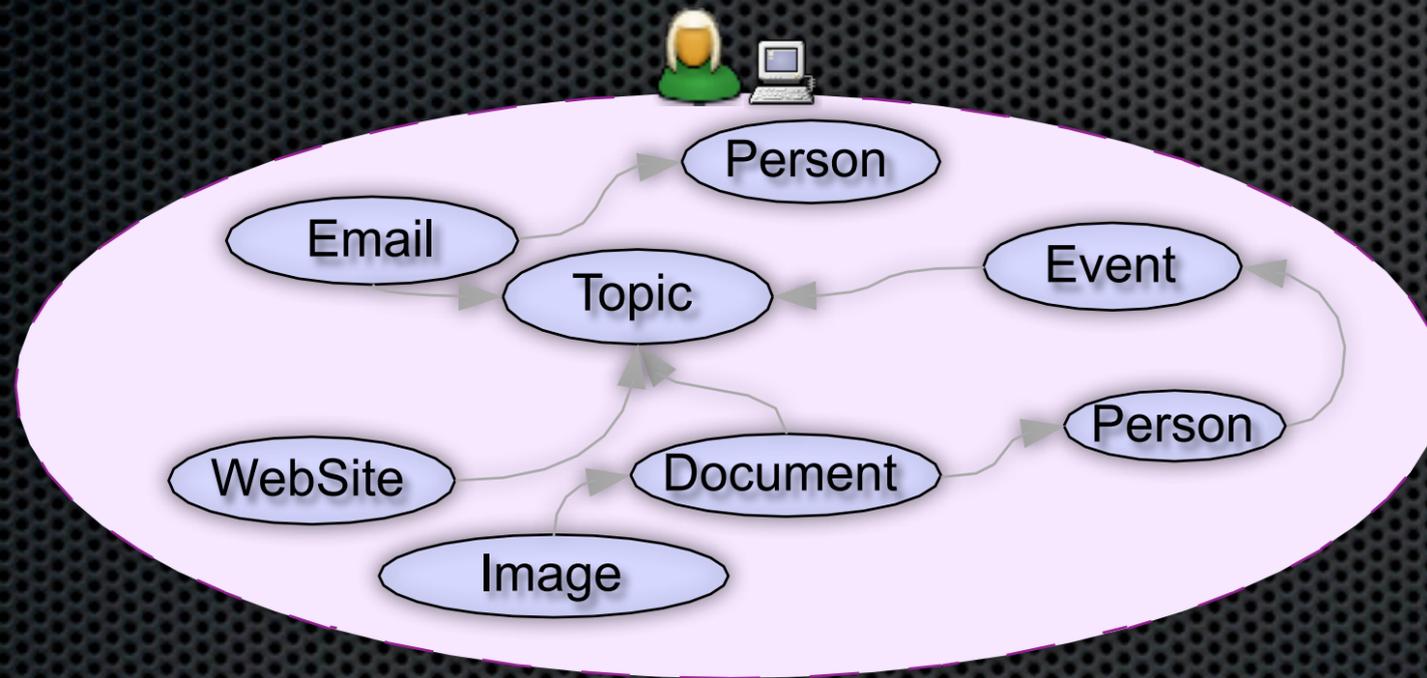
NEPOMUK enabled peers

Personal Information Model PIMO



Articulate and link concepts with
relations

Personal Information Model PIMO



Articulate and link concepts with relations

Miniquire

Desktop Search

Pimo

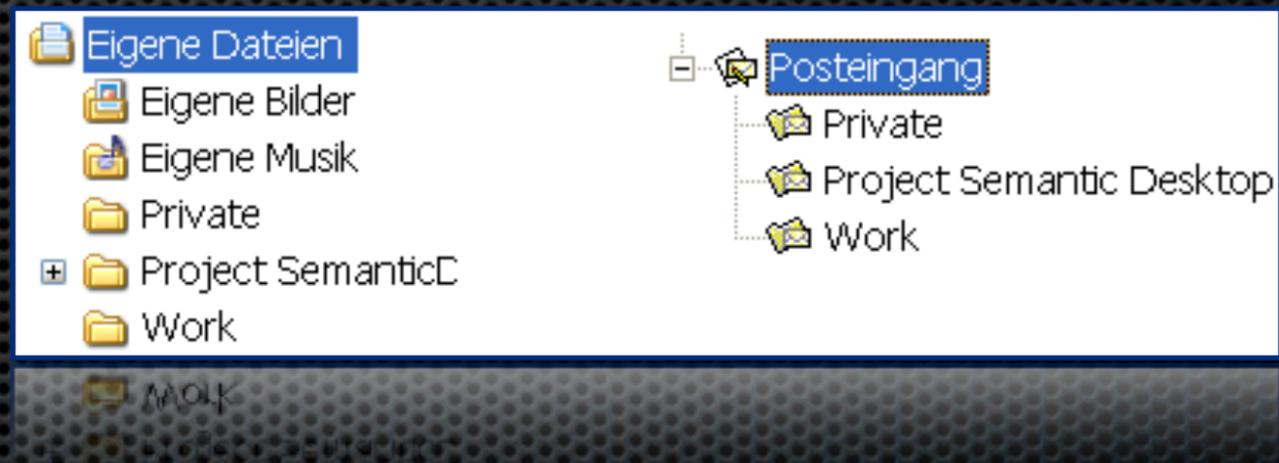
- Thing
 - Group
 - Knowledge-based Systems Group
 - Location
 - LogicalMediaType
 - Music
 - Online Account
 - Organization
 - DFKI GmbH
 - University of Kaiserslautern
 - Person
 - ProcessConcept
 - Event
 - Lehrveranstaltung
 - Bachelor-Seminar
 - Praktikum/Projekt
 - Künstliche Intelligenz WS04/05
 - Künstliche Intelligenz WS05/06
 - Künstliche Intelligenz WS06/07
 - Semantic Desktop Technologies
 - Wissensmanagement SS05 (Prak
 - Wissensmanagement SS06 (Prak
 - Seminar
 - Vorlesung
 - Fallbasiertes Schließen (V) WS06
 - Semantic Web
 - 26MANUC W6D
 - FALLBASIERTES SCHLIESSEN (V) WS06

How can we support knowledge articulation?

Building your personal semantic web



Existing structures

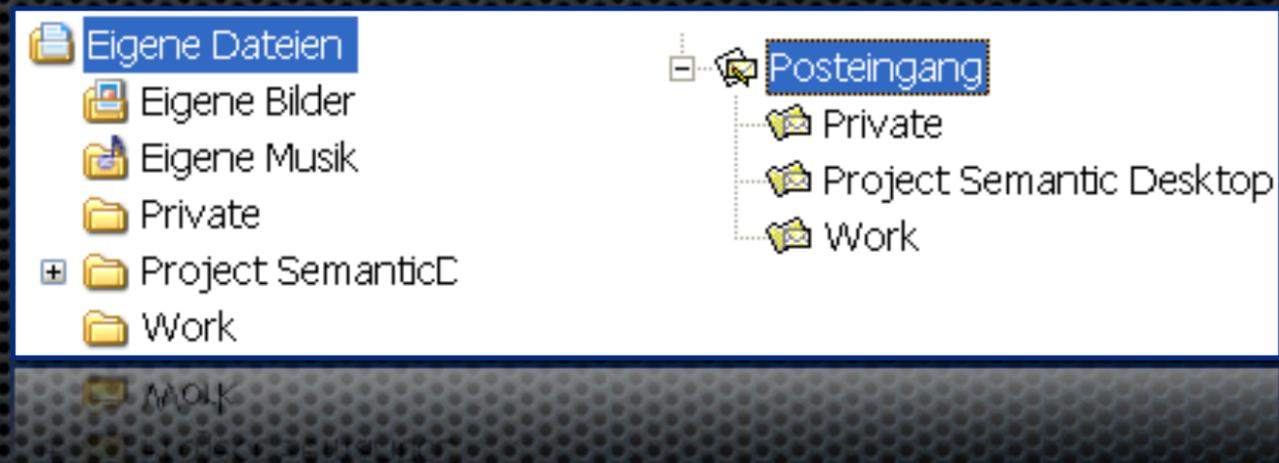


Building your personal semantic web

**Semantic
Desktop**



**Existing
structures**

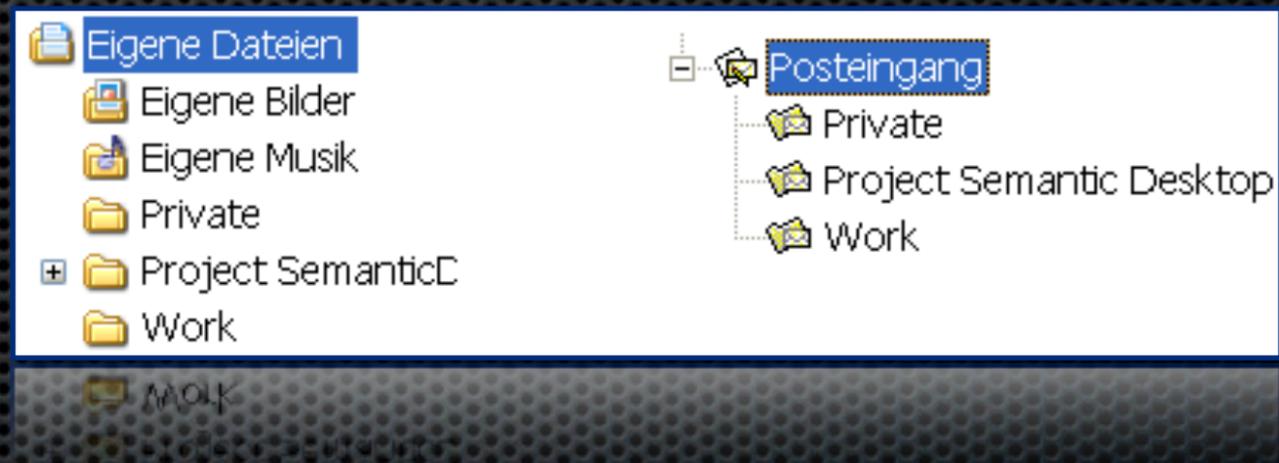


Building your personal semantic web

**Semantic
Desktop**



**Existing
structures**

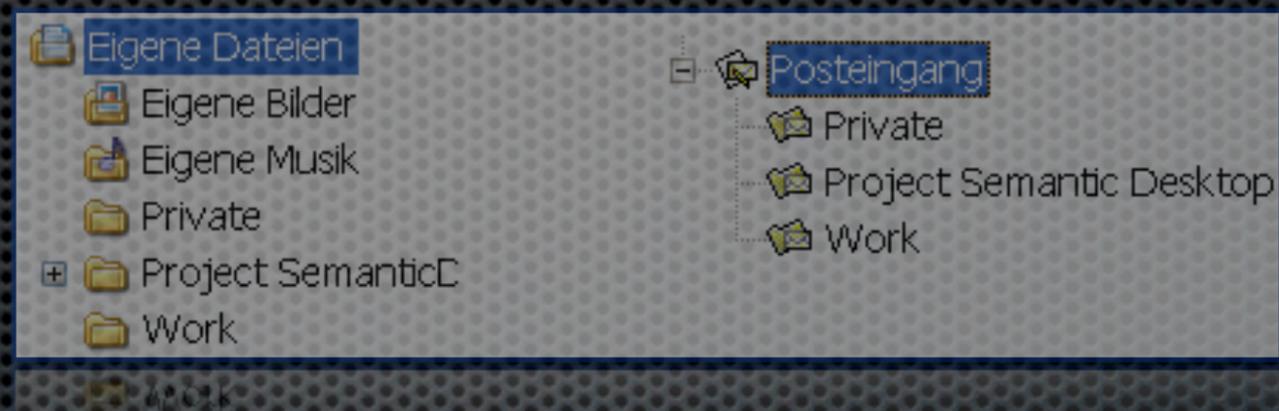


Rebirth example: PIMO person

Semantic Desktop



Existing structures



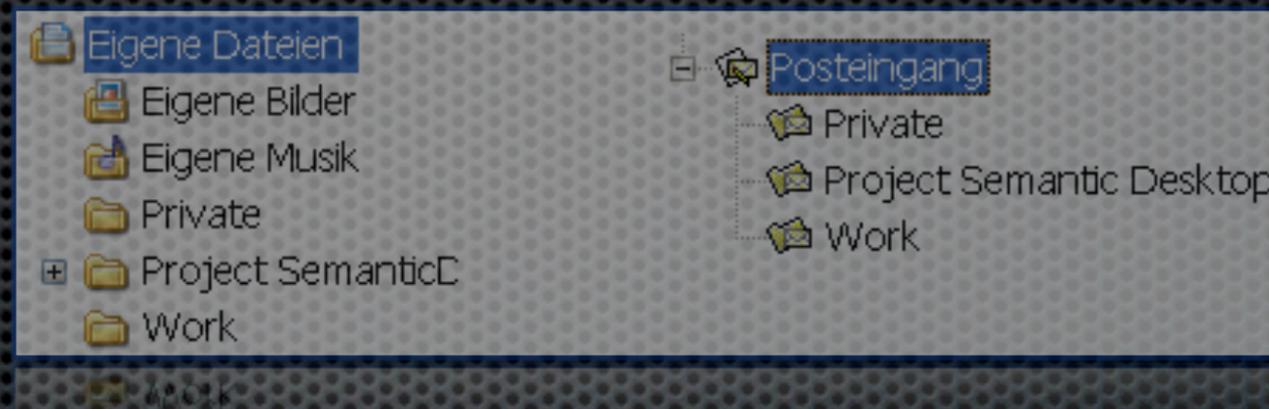
Rebirth example: PIMO person

Semantic Desktop

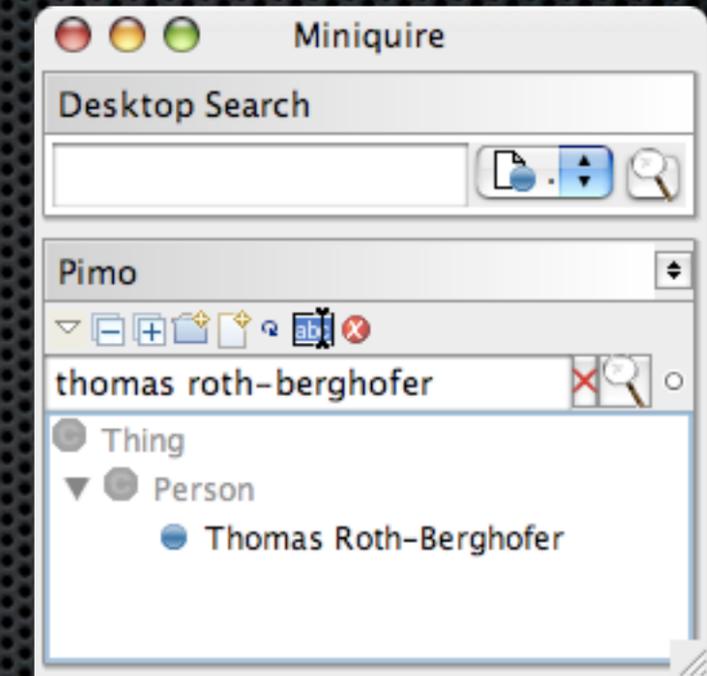


„Rebirth“

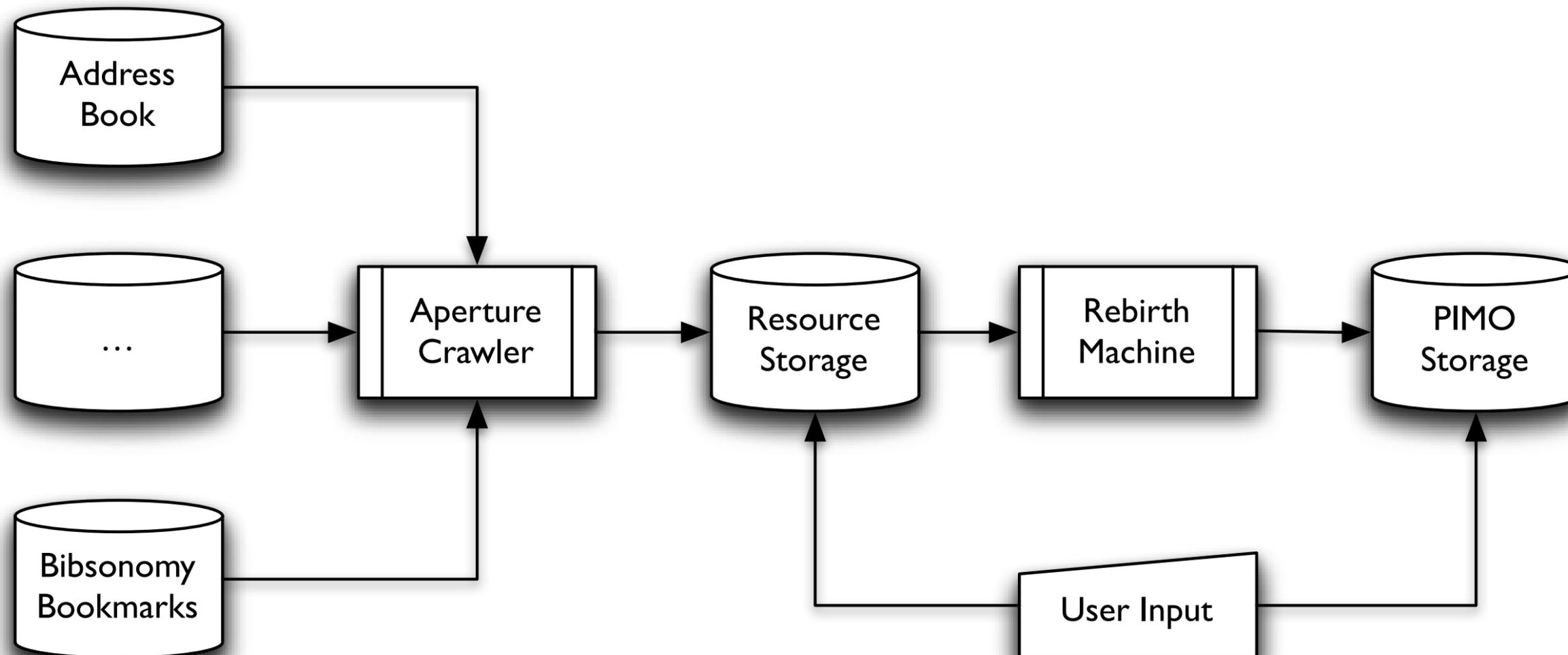
Existing structures



Apple Addressbook



Import and rebirth process: Schematic overview



Address Book [Minimize] [Maximize] [Close]

File Edit View Tools Help

New Card New List Properties Write Delete

Address Books

Name	Email	Screen Name	Organization	Work Phone
Jane Doe	does@whoisit.net			
John Doe	does@whoisit.net			
Jolly Joker	joker@cards.com			
Max Mustermann	muster@standard.de			
Person Name	free@mail.fi			

Card for John Doe

Contact

Display Name: John Doe
 Email: does@whoisit.net

5 matches found



Address Book [min] [max] [close]

File Edit View Tools Help

New Card New List Properties Write Delete

Address Books

Name	Email	Screen Name	Organization	Work Phone
Jane Doe	does@whoisit.net			
John Doe	does@whoisit.net			
Jolly Joker	joker@cards.com			
Max Mustermann	muster@standard.de			
Person Name	free@mail.fi			

Card for John Doe

Contact

Display Name: John Doe
Email: does@whoisit.net

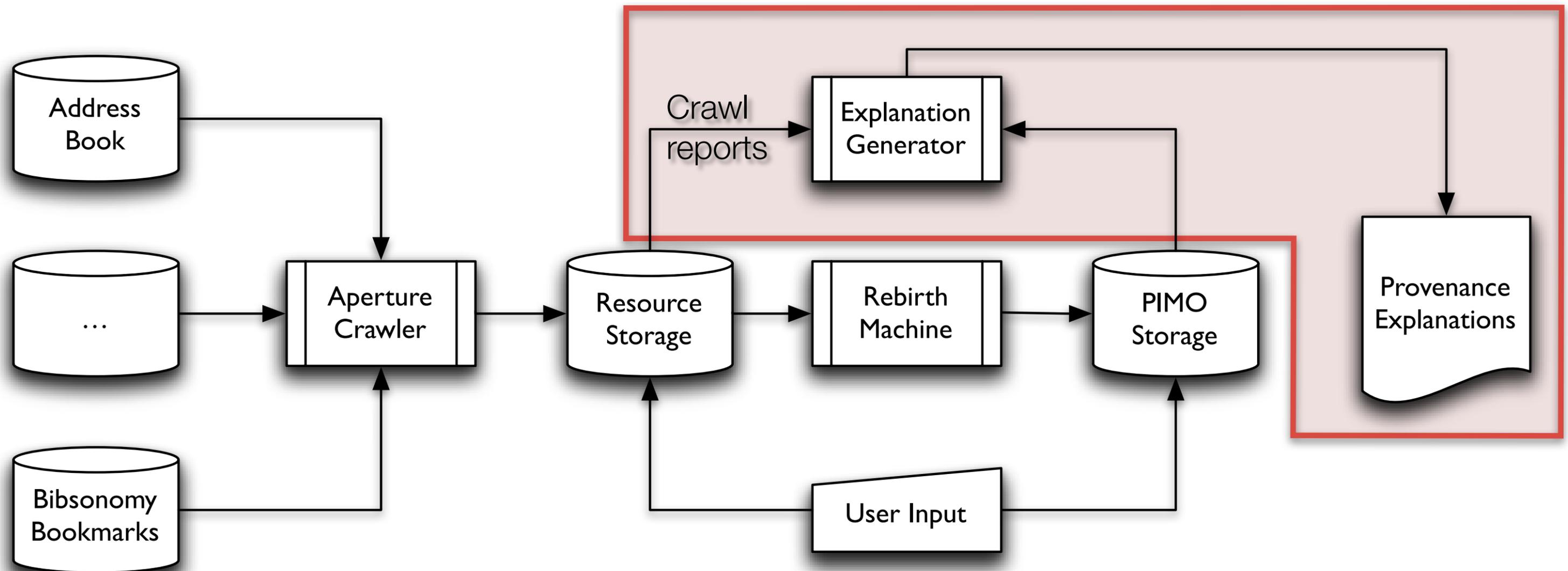
5 matches found



Person

- Jane Doe
- John Doe**
- Jolly Joker
- Markus Eppert
- Max Mustermann
- Person Name

Provenance explanations from crawl reports



Provenance Explanations

This explanation describes the import/creation process of the PIMO item "JohnDoe".

"JohnDoe" is a Person in PIMO, because the data source it has been crawled from is an address book.

"JohnDoe" has been crawled from:

DataSource	Started	Finished	New Objects	Deleted Objects	Modified Objects	Not Modified Objects	
"Address Book" (http://aperture.semanticdesktop.org/ontology/source#AddressbookDataSource)	"2007-03-05T14:17:11"	"2007-03-05T14:17:11"	"3"	NULL	NULL	"1"	view details

An address book entry describes features of a person. Only the primary e-mail address is used at the moment to identify the person, other information is not used. An import of an address book entry is transformed into an instance of the PIMO class "Person".

Provenance Explanations

This explanation describes the import/creation process of the PIMO item "JohnDoe".

"JohnDoe" is a Person in PIMO, because the data source it has been crawled from is an address book.

"JohnDoe" has been crawled from:

DataSource	Started	Finished	New Objects	Deleted Objects	Modified Objects	Modified Objects	
"Address Book" (http://aperture.semanticdesktop.org/ontology/source#AddressbookDataSource)	"2007-03-05T14:17:11"	"2007-03-05T14:17:11"	"3"	NULL	NULL	"1"	view details

An address book entry describes features of a person. Only the primary e-mail address is used at the moment to identify the person, other information is not used. An import of an address book entry is transformed into an instance of the PIMO class "Person".



Version 0.9.0

[Gnowsis](#) [Ontologies](#) [Crawl Report](#) [Database](#) [Admin](#) [Debug](#) [Sync](#)

Provenance Explanations

This explanation describes the import/creation process of the PIMO item "JohnDoe".

"JohnDoe" is a Person in PIMO, because the data source it has been crawled from is an address book.

"JohnDoe" has been crawled from:

DataSource	Started	Finished	New Objects	Deleted Objects	Modified Objects	Modified Objects	
"Address Book" (http://aperture.semanticdesktop.org/ontology/source#AddressbookDataSource)	"2007-03-05T14:17:11"	"2007-03-05T14:17:11"	"3"	NULL	NULL	"1"	view details

An address book entry describes features of a person. Only the primary e-mail address is used at the moment to identify the person, other information is not used. An import of an address book entry is transformed into an instance of the PIMO class "Person".

Status and plans

- ✦ Markus Eppert (graduate student) developed first prototype for basic provenance explanations of crawled and reborn addressbook entries.
- ✦ Follow-up diploma thesis: „Design and development of a generic explanation component for the rebirth machine“
- ✦ Florian Mittag (graduate student) develops a decision tracking component on top of a Justification-based Truth Maintenance system.

Explanations in myCBR



Case-Based Reasoning (CBR) is ...

- A problem solving approach:

New problems are solved based on the solutions of similar past problems.

- Basic assumption:

Similar problems have similar solutions.

Typical examples

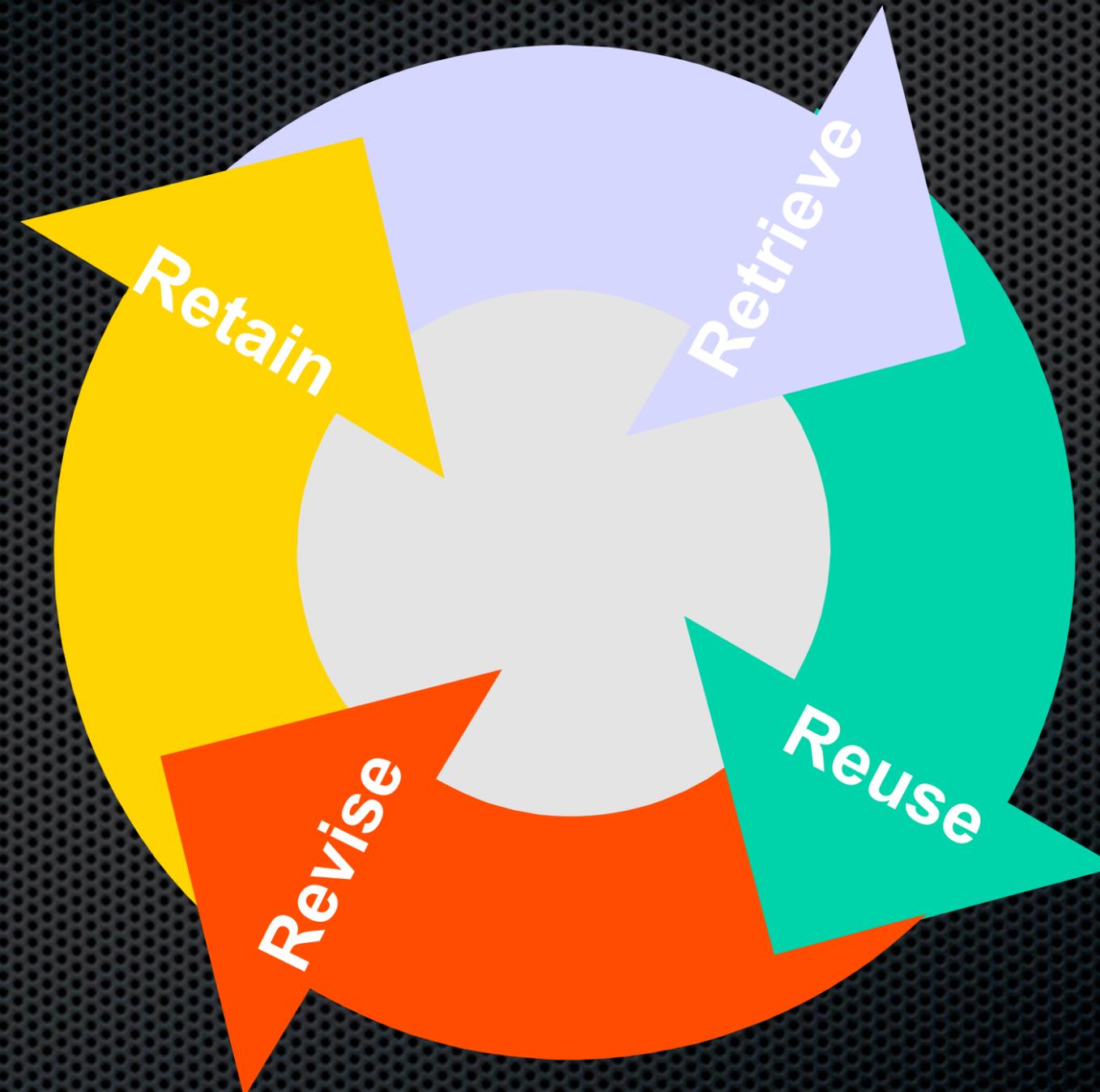
- An **auto mechanic** who fixes an engine by recalling another car that exhibited similar symptoms is using case-based reasoning.
- A **lawyer** who advocates a particular outcome in a trial based on legal precedents or a judge who creates case law is using case-based reasoning.
- In **e-commerce** scenarios: Similarity-based product retrieval and recommendation.

Typical examples

- An **auto mechanic** who fixes an engine by recalling another car that exhibited similar symptoms is using case-based reasoning.
- A **lawyer** who advocates a particular outcome in a trial based on legal precedents or a judge who creates case law is using case-based reasoning.
- In **e-commerce** scenarios: Similarity-based product retrieval and recommendation.

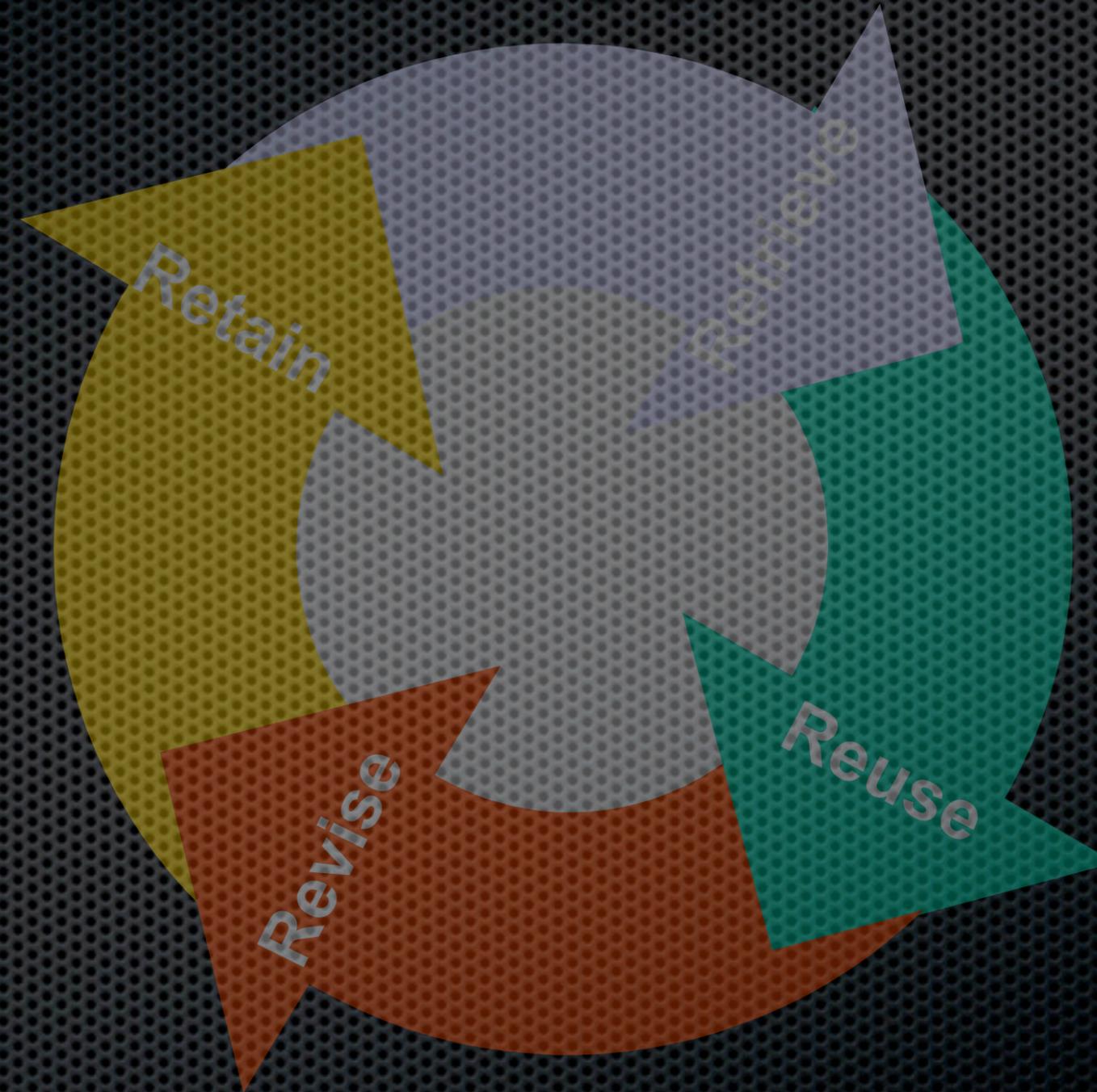
Traditional
view

The CBR process model



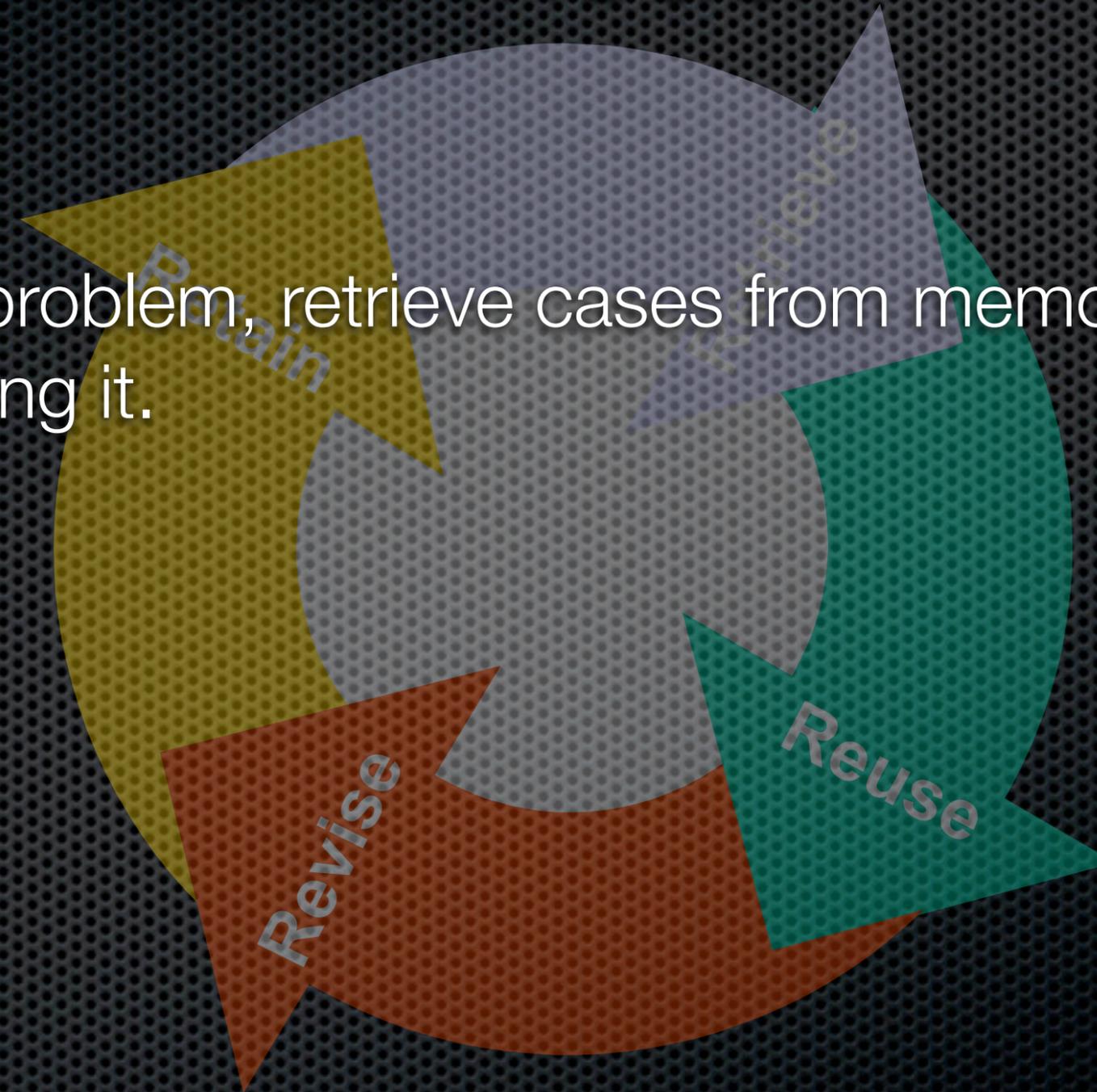
Agnar Aamodt and Eric Plaza. Case-based reasoning: Foundational issues, methodological variations, and system approaches. *AI Communications*, 7(1):39–59, 1994.

The CBR process model



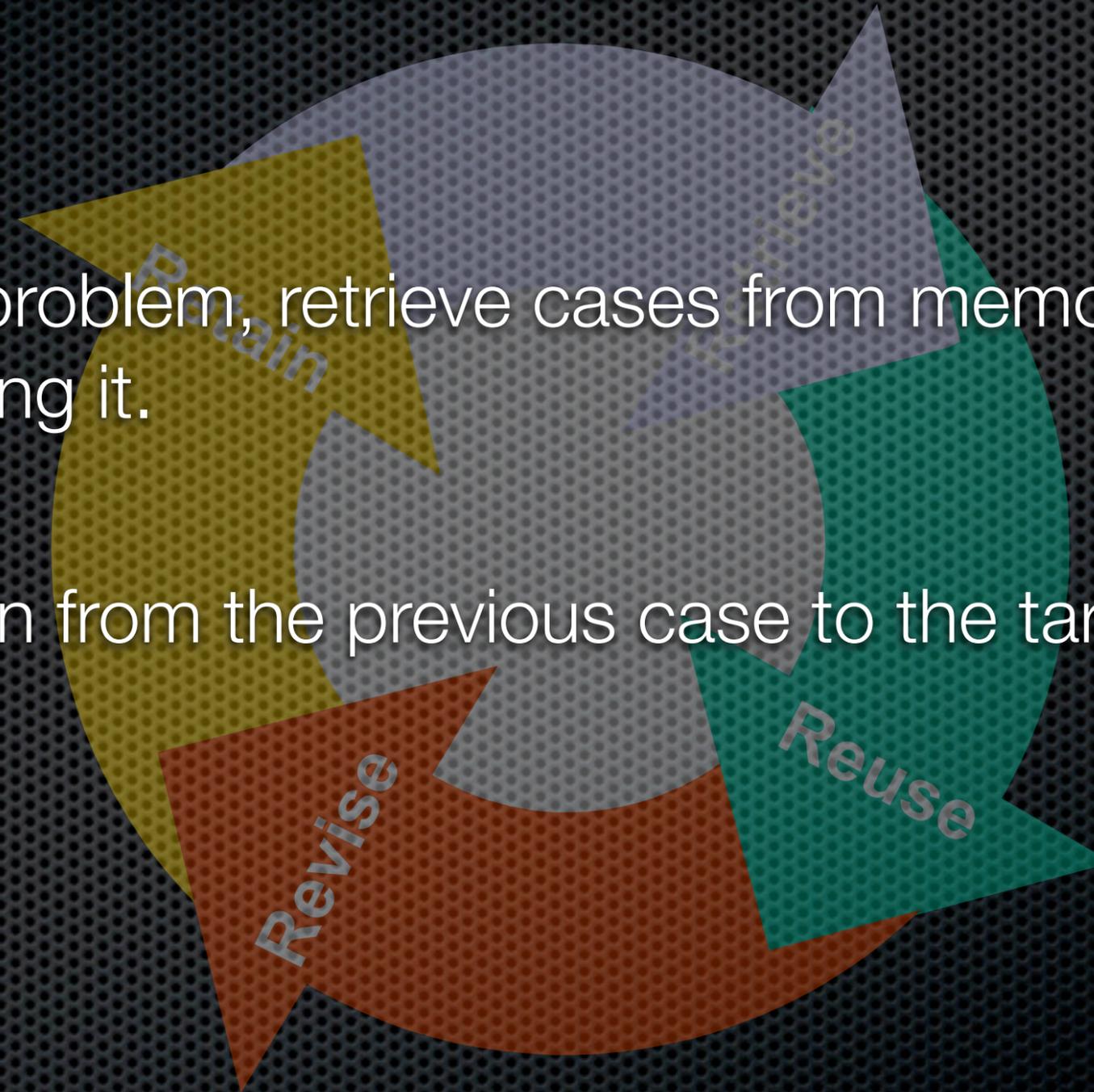
The CBR process model

- Retrieve:
Given a target problem, retrieve cases from memory that are relevant to solving it.



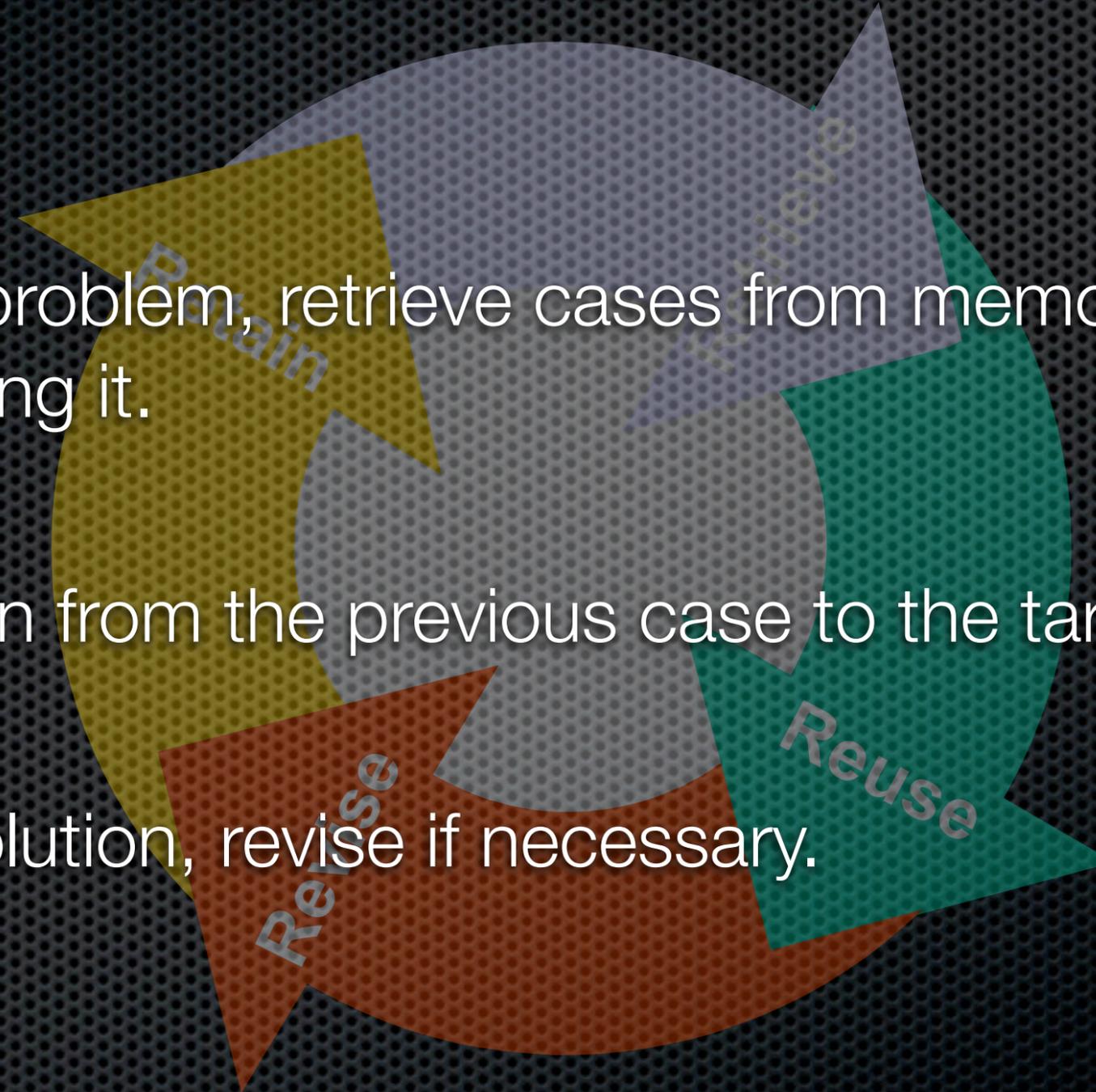
The CBR process model

- Retrieve:
Given a target problem, retrieve cases from memory that are relevant to solving it.
- Reuse:
Map the solution from the previous case to the target problem.



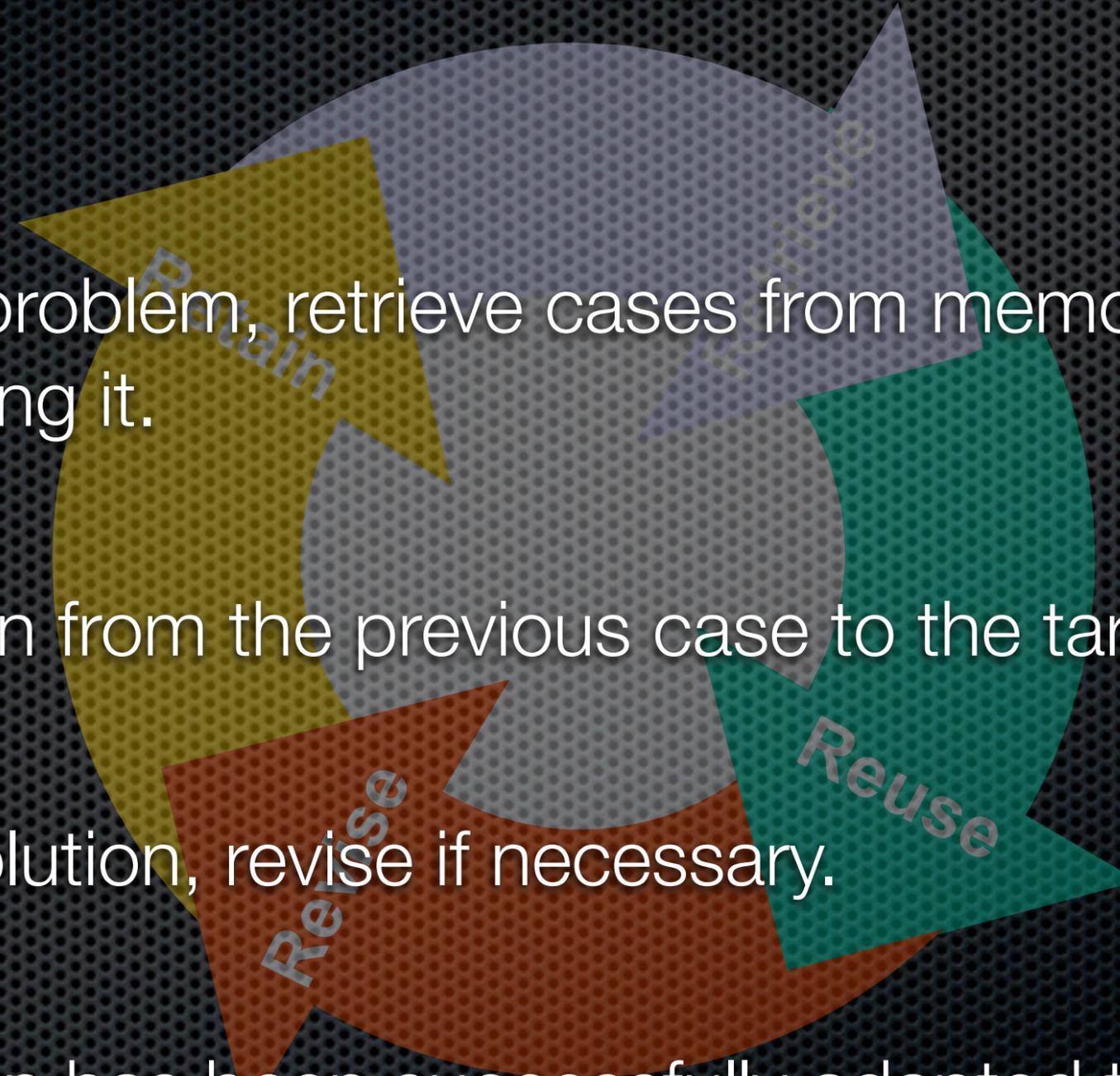
The CBR process model

- Retrieve:
Given a target problem, retrieve cases from memory that are relevant to solving it.
- Reuse:
Map the solution from the previous case to the target problem.
- Revise:
Test the new solution, revise if necessary.



The CBR process model

- Retrieve:
Given a target problem, retrieve cases from memory that are relevant to solving it.
- Reuse:
Map the solution from the previous case to the target problem.
- Revise:
Test the new solution, revise if necessary.
- Retain:
After the solution has been successfully adapted to the target problem, store the resulting experience as a new case in memory.



The CBR process model

- Retrieve:
Given a target problem, retrieve cases from memory that are relevant to solving it.
- Reuse:
Map the solution from the previous case to the target problem.
- Revise:
Test the new solution, revise if necessary.
- Retain:
After the solution has been successfully adapted to the target problem, store the resulting experience as a new case in memory.

Knowledge containers

- ✦ Concept introduced by M. M. Richter (in 1995)
- ✦ Contain and structure the knowledge of a CBR system
- ✦ Collection of knowledge that is relevant to many tasks
- ✦ Knowledge containers in rule-based systems:

Facts

Rules



M. Lenz, B. Bartsch-Spörl, H.-D. Burkhard, and S. Wess, editors.
Case-Based Reasoning Technology: From Foundations to Applications.
LNAI. Springer-Verlag, Berlin, 1998.

Knowledge Containers

- **Vocabulary**

- Structure of the domain schema, e.g., classes, attributes, allowed values
 - Basis for the three other knowledge containers

- **Similarity measures**

- define how the most useful cases are retrieved
 - define by what means the similarity is calculated

- **Solution transformation (or adaptation) knowledge**

- covers the knowledge for translating prior solutions to fit a given query

- **Case base**

- stores the experience of the CBR system in the form of cases

Knowledge Containers

- **Vocabulary**

 - Structure of the domain schema, e.g., classes, attributes, allowed values
 - Basis for the three other knowledge containers

- **Similarity measures**

 - define how the most useful cases are retrieved
 - define by what means the similarity is calculated

- **Solution transformation (or adaptation) knowledge**

 - covers the knowledge for translating prior solutions to fit a given query

- **Case base**

 - stores the experience of the CBR system in the form of cases

(some) myCBR features

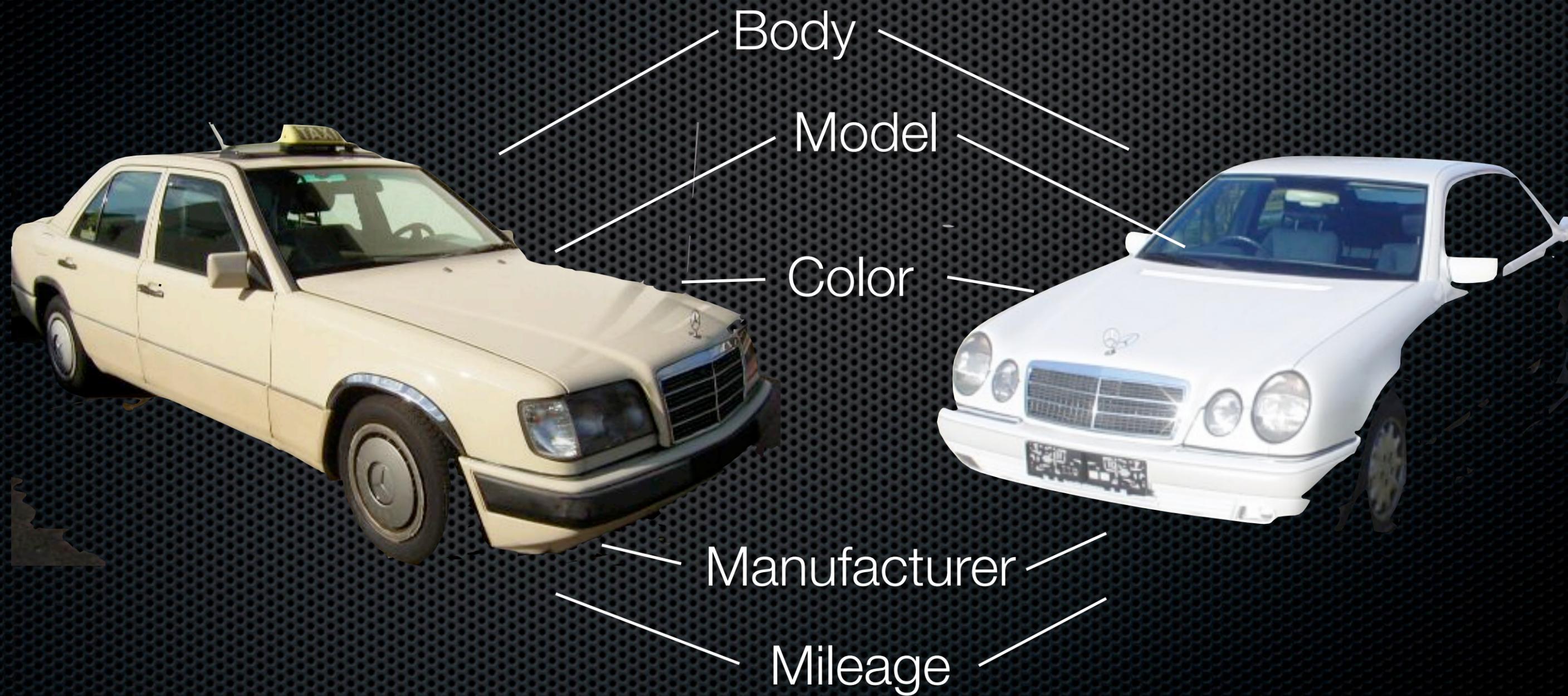
- ✦ Plugin for popular ontology editor Protégé (Version 3.x)
- ✦ Extensions provided by myCBR (current Version 2.0 *beta*):
 - Easy import of raw data (csv-files)
 - GUIs for modelling knowledge-intensive similarity measures
 - Similarity-based retrieval functionality
 - Export of domain model and similarity measures in XML format
- ✦ Stand-alone retrieval engine for separate use / integration

More information and download:  <http://mycbr-project.net>

How do you compare used cars?



Comparing features



Class „Car“

autos Protégé 3.1.1 (file:/Users/roth/Documents/workspace/mycbr/distribution/samples/auto_set/autos.pprj, Protégé Files (.pont and .pins))

Classes Slots Forms Instances Similarity Modeling CBR Retrieval

CLASS BROWSER
For Project: autos

Class Hierarchy

- :THING
 - :SYSTEM-CLASS
 - Car
 - Soundsystem

CLASS EDITOR
For Class: Car (instance of :STANDARD-CLASS)

Name: Car

Documentation:

Constraints:

Role: Concrete

Template Slots

Name	Cardinality	Type	Other Facets
Body	single	Symbol	allowed-values={convertible,coupe,fastback,roadster,edan...}
Car Code	single	Integer	minimum=0, maximum=10000000
CCM	single	Integer	minimum=1000, maximum=6000
Color	single	Symbol	allowed-values={anthracite,black,blue,dark_blue,dark_gray,...}
Doors	single	Integer	minimum=2, maximum=7
Extras	multiple	Symbol	allowed-values={ABS,ESP,Navigation}
Gas	single	Symbol	allowed-values={diesel,gasoline}
Manufacturer	single	Symbol	allowed-values={audi,bmw,mercedes-benz,vw}
Miles	single	Integer	minimum=0, maximum=1000000
Model	single	Symbol	allowed-values={316i,318i,320i,323i,325td,325tds,328i,5...}
Power	single	Integer	minimum=10, maximum=1000
Price	single	Integer	minimum=1, maximum=1000000
Sound	single	Instance of Soundsystem	
Speed	single	Integer	minimum=100, maximum=300
Year	single	Float	minimum=1950.0, maximum=2007.0
ZIP	single	Integer	minimum=0, maximum=9

Superclasses

- :THING

Name

Car

Documentation

Constraints



Role

Concrete ●

Template Slots



Name	Cardinality	Type	Other Facets
Body	single	Symbol	allowed-values={convertible,coupe,fastback,roadster,edan...}
Car Code	single	Integer	minimum=0, maximum=10000000
CCM	single	Integer	minimum=1000, maximum=6000
Color	single	Symbol	allowed-values={anthracite,black,blue,dark_blue,dark_gray,...}
Doors	single	Integer	minimum=2, maximum=7
Extras	multiple	Symbol	allowed-values={ABS,ESP,Navigation}
Gas	single	Symbol	allowed-values={diesel,gasoline}
Manufacturer	single	Symbol	allowed-values={audi,bmw,mercedes-benz,vw}
Miles	single	Integer	minimum=0, maximum=1000000
Model	single	Symbol	allowed-values={316i,318i,320i,323i,325td,325tds,328i,5...}
Power	single	Integer	minimum=10, maximum=1000
Price	single	Integer	minimum=1, maximum=1000000
Sound	single	Instance of Soundsystem	
Speed	single	Integer	minimum=100, maximum=300
Year	single	Float	minimum=1950.0, maximum=2007.0
ZIP	single	Integer	minimum=0, maximum=9

Name: Car

Documentation:

Constraints:

Role: Concrete

Template Slots:

Name	Cardinality	Type	Other Facets
Body	single	Symbol	allowed-values={convertible,coupe,fastback,roadster,edan...}
Car Code	single	Integer	minimum=0, maximum=10000000
CCM	single	Integer	minimum=1000, maximum=6000
Color	single	Symbol	allowed-values={anthracite,black,blue,dark_blue,dark_gray,...}
Doors	single	Integer	minimum=2, maximum=7
Extras	multiple	Symbol	allowed-values={ABS,ESP,Navigation}
Gas	single	Symbol	allowed-values={diesel,gasoline}
Manufacturer	single	Symbol	allowed-values={audi,bmw,mercedes-benz,vw}
Miles	single	Integer	minimum=0, maximum=1000000
Model	single	Symbol	allowed-values={316i,318i,320i,323i,325td,325tds,328i,5...}
Power	single	Integer	minimum=10, maximum=1000
Price	single	Integer	minimum=1, maximum=1000000
Sound	single	Instance of Soundsystem	
Speed	single	Integer	minimum=100, maximum=300
Year	single	Float	minimum=1950.0, maximum=2007.0
ZIP	single	Integer	minimum=0, maximum=9

Name: Car

Role: Concrete

Documentation: [Empty]

Constraints: [Empty]

Template Slots

Name	Cardinality	Type	Other Facets
Body	single	Symbol	allowed-values={convertible,coupe,fastback,roadster,edan...}
Car Code	single	Integer	minimum=0, maximum=10000000
CCM	single	Integer	minimum=1000, maximum=6000
Color	single	Symbol	allowed-values={anthracite,black,blue,dark_blue,dark_gray,...}
Doors	single	Integer	minimum=2, maximum=7
Extras	multiple	Symbol	allowed-values={ABS,ESP,Navigation}
Gas	single	Symbol	allowed-values={diesel,gasoline}
Manufacturer	single	Symbol	allowed-values={audi,bmw,mercedes-benz,vw}
Miles	single	Integer	minimum=0, maximum=1000000
Model	single	Symbol	allowed-values={316i,318i,320i,323i,325td,325tds,328i,5...}
Power	single	Integer	minimum=10, maximum=1000
Price	single	Integer	minimum=1, maximum=1000000
Sound	single	Instance of Soundsystem	
Speed	single	Integer	minimum=100, maximum=300
Year	single	Float	minimum=1950.0, maximum=2007.0
ZIP	single	Integer	minimum=0, maximum=9

Car instances

The screenshot shows the Protégé 3.1.1 interface with the Instance Editor window open. The Instance Editor is titled "INSTANCE EDITOR" and is for instance 100 of the class "Car". It contains a grid of property-value pairs:

Property	Value
Car Code	100
CCM	3000
Year	1996.0
Body	sedan
Sound	
Doors	4
Miles	18146
Color	yellow
Gas	diesel
Extras	Navigation
Power	176
Price	58499
Manufacturer	mercedes...
Model	e_300_die...
Speed	224
ZIP	3

The Instance Editor window is highlighted with a red border. The background shows the Class Browser and Instance Browser panels.

Car instances

The screenshot displays a software interface with two main panels: **INSTANCE BROWSER** and **INSTANCE EDITOR**.

INSTANCE BROWSER: Shows a list of instances for the class **Car**. The instances are numbered 10 through 11, with instance 100 selected.

INSTANCE EDITOR: Shows the details for instance 100 (instance of Car). The fields are organized as follows:

Field	Value
Car Code	100
CCM	3000
Year	1996.0
Body	sedan
Sound	
Doors	4
Miles	18146
Color	yellow
Gas	diesel
Extras	Navigation
Power	176
Price	58499
Manufacturer	mercedes...
Model	e_300_die...
Speed	224
ZIP	3

Global similarity measure

autos Protégé 3.1.1 (file:/Users/roth/Documents/workspace/mycbr/distribution/samples/auto_set/autos.pprj, Protégé Files (.pont and .pins))

Classes Slots Forms Instances Similarity Modeling CBR Retrieval

CLASS BROWSER
For Project: autos
Class Hierarchy
:THING
:SYSTEM-CLASS
Car
Soundsystem

SLOT BROWSER
For Project: autos
Slot Hierarchy
Gas
Power
Model
Doors
ZIP
Sound
Color
Extras
Year
Body
Manufacturer
CCM
Car Code
Price
Speed

SIMILARITY MEASURE FUNCTIONS
Available functions
CarFunc
New Duplicate
Delete Active

Attributes (Slots):

attribute	discriminant	weight	comment
Body	<input checked="" type="checkbox"/>	1	
CCM	<input checked="" type="checkbox"/>	1	
Car Code	<input type="checkbox"/>	1	
Color	<input checked="" type="checkbox"/>	1	
Doors	<input checked="" type="checkbox"/>	1	
Gas	<input checked="" type="checkbox"/>	1	
Manufacturer	<input checked="" type="checkbox"/>	1	
Miles	<input checked="" type="checkbox"/>	1	
Model	<input checked="" type="checkbox"/>	1	
Power	<input checked="" type="checkbox"/>	1	
Price	<input checked="" type="checkbox"/>	1	
Speed	<input checked="" type="checkbox"/>	1	
Year	<input checked="" type="checkbox"/>	1	
ZIP	<input type="checkbox"/>	1	
Extras	<input checked="" type="checkbox"/>	1	
Sound	<input checked="" type="checkbox"/>	1	

cannot inherit! Weighted Sum Minimum
 Euclidean Maximum

- Feature match: local similarity measures
- Class similarity: aggregate local similarities

Weighted sum

Maximum

Minimum

Euclidian distance

Global similarity measure

CLASS BROWSER
For Project: autos
Class Hierarchy
:THING
:SYSTEM-CLASS
Car
Soundsystem

SLOT BROWSER
For Project: autos
Slot Hierarchy
Gas
Power
Model
Doors
ZIP
Sound
Color
Extras
Year
Body
Manufacturer
CCM
Car Code
Price
Speed

SIMILARITY MEASURE FUNCTIONS
Available functions
CarFunc
New Duplicate
Delete Active

Attributes (Slots):

attribute	discriminant	weight	comment
Body	<input checked="" type="checkbox"/>	1	
CCM	<input checked="" type="checkbox"/>	1	
Car Code	<input type="checkbox"/>	1	
Color	<input checked="" type="checkbox"/>	1	
Doors	<input checked="" type="checkbox"/>	1	
Gas	<input checked="" type="checkbox"/>	1	
Manufacturer	<input checked="" type="checkbox"/>	1	
Miles	<input checked="" type="checkbox"/>	1	
Model	<input checked="" type="checkbox"/>	1	
Power	<input checked="" type="checkbox"/>	1	
Price	<input checked="" type="checkbox"/>	1	
Speed	<input checked="" type="checkbox"/>	1	
Year	<input checked="" type="checkbox"/>	1	
ZIP	<input type="checkbox"/>	1	
Extras	<input checked="" type="checkbox"/>	1	
Sound	<input checked="" type="checkbox"/>	1	

cannot inherit!

Weighted Sum Minimum
 Euclidean Maximum

- Feature match: local similarity measures
- Class similarity: aggregate local similarities

Weighted sum

Maximum

Minimum

Euclidian distance

Important attributes

Attributes (Slots):			
attribute	discriminant	wei...	comment
Manufacturer	<input checked="" type="checkbox"/>	7	Activ... Car manufacturer
Price	<input checked="" type="checkbox"/>	7	Activ... Basis for negotiation
Body	<input checked="" type="checkbox"/>	5	Activ... Car body
Color	<input checked="" type="checkbox"/>	5	Activ... Car color
Model	<input checked="" type="checkbox"/>	5	Activ... Car model
Miles	<input checked="" type="checkbox"/>	3	Activ... Mileage
Power	<input checked="" type="checkbox"/>	3	Activ... Horse power
Doors	<input checked="" type="checkbox"/>	2	Activ... Number of doors
CCM	<input checked="" type="checkbox"/>	1	Activ... Cylinder capacity
Car Code	<input type="checkbox"/>	1	Activ... Identifier; not used for retrieval
Gas	<input checked="" type="checkbox"/>	1	Activ... Type of fuel
Speed	<input checked="" type="checkbox"/>	1	Activ... Top speed
Year	<input checked="" type="checkbox"/>	1	Activ... Year of production
ZIP	<input type="checkbox"/>	1	Activ... Area of seller (first digit; Germany); not used for retrieval

Local similarities: Car body

The screenshot shows the Protégé 3.1.1 interface with the Similarity Modeling tab active. The Class Browser on the left shows a hierarchy for the 'autos' project, with 'Car' selected under ':SYSTEM-CLASS'. The Slot Browser on the left shows a list of slots, with 'Body' selected. The Similarity Measure Functions panel shows 'BodyFunc' as the selected function. The Similarity mode is set to 'Table' and Symmetry is set to 'symmetric'. The main area displays a similarity matrix for car body types.

Similarity mode: Table ?

Symmetry: symmetric asymmetric ?

Reset	convertible	coupe	fastback	roadster	sedan	station_wagon
convertible	1.0	0.0	0.2	0.7	0.0	0.0
coupe	0.0	1.0	0.2	0.0	0.7	0.5
fastback	0.2	0.2	1.0	0.5	0.0	0.0
roadster	0.7	0.0	0.5	1.0	0.0	0.0
sedan	0.0	0.7	0.0	0.0	1.0	0.8
station_w...	0.0	0.5	0.0	0.0	0.8	1.0

Query Values

q='roadster', c='sedan'

Local similarities: Car body

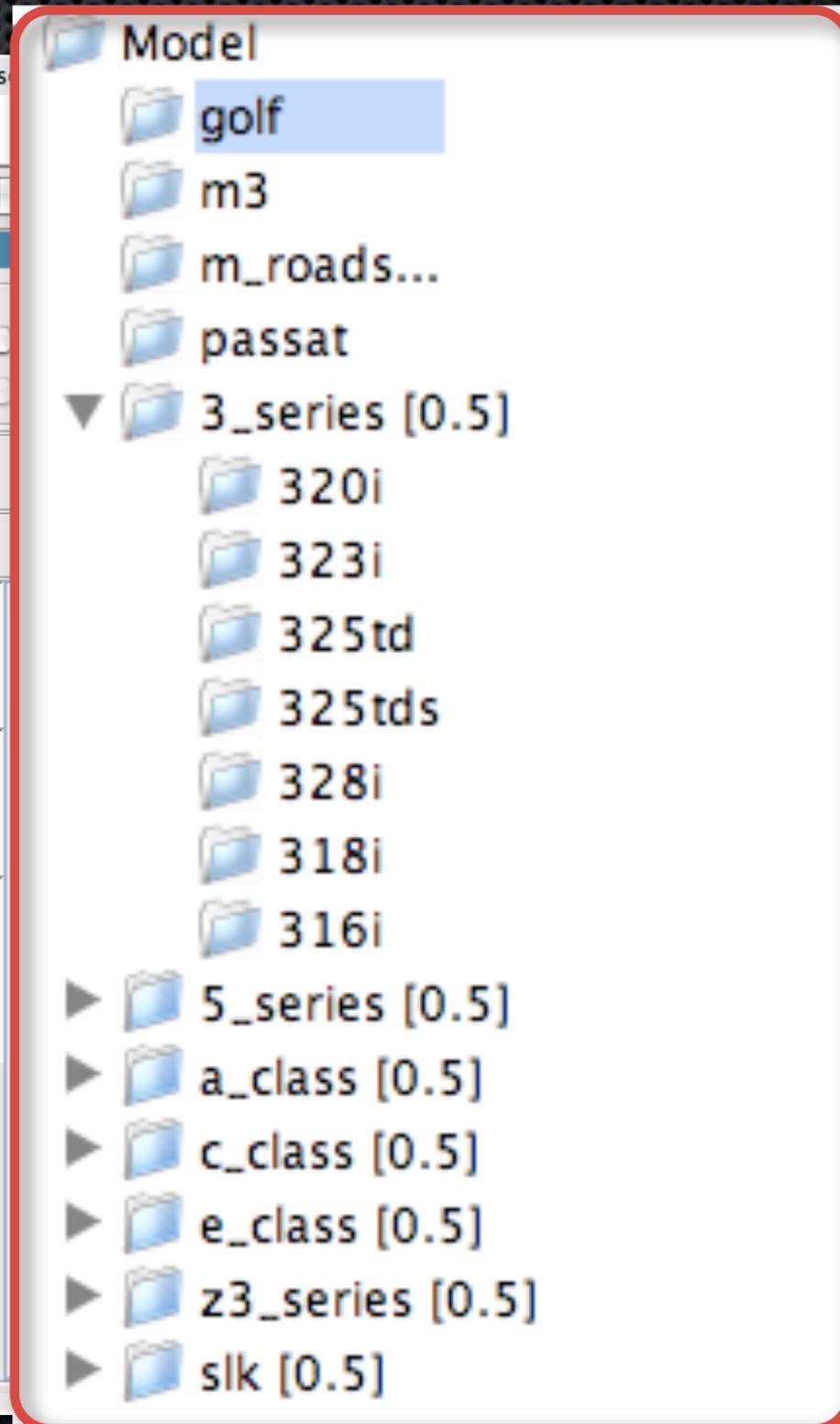
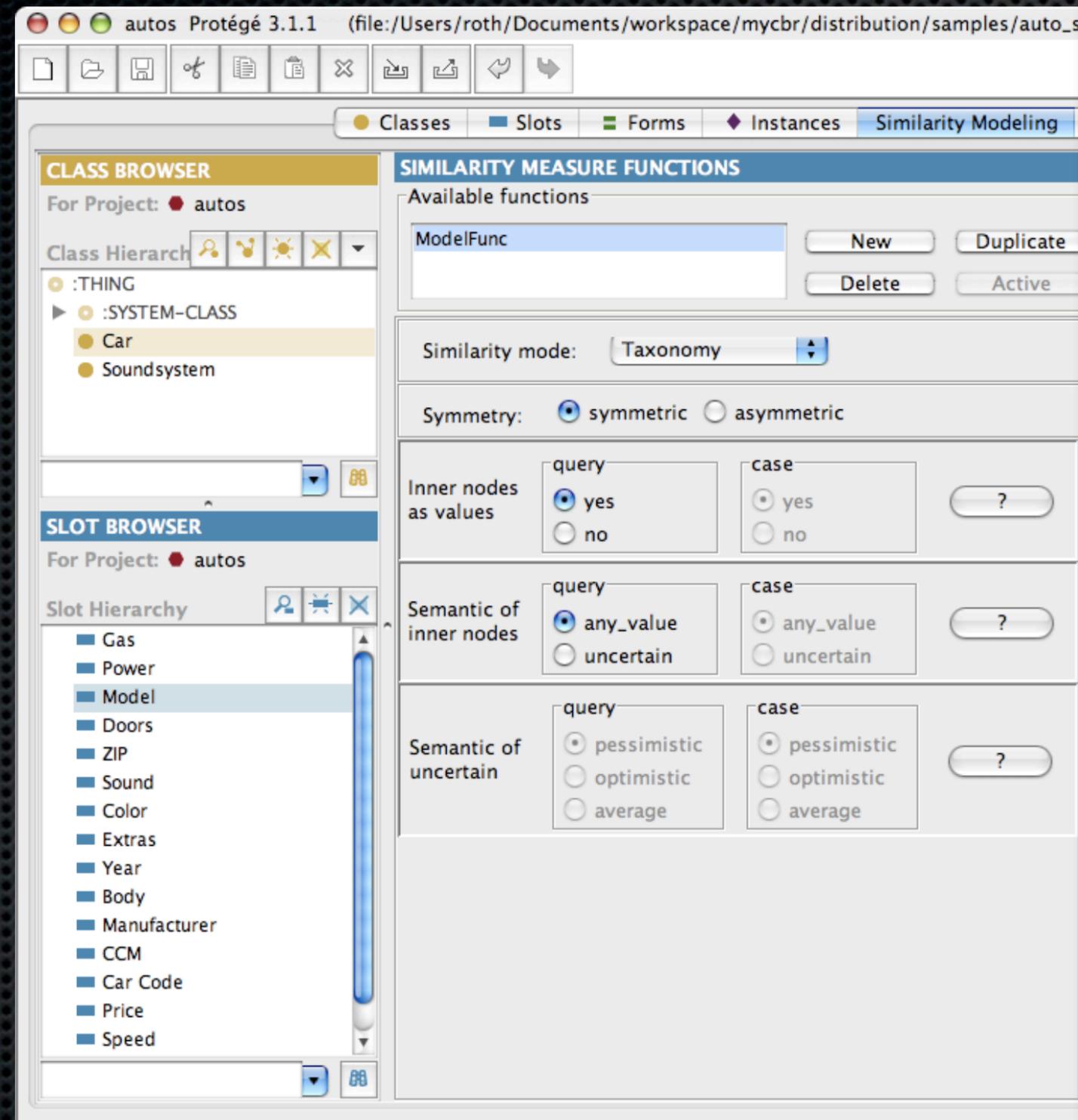
The screenshot shows the Protégé 3.1.1 interface with the 'Similarity Modeling' tab active. The 'SIMILARITY MEASURE FUNCTIONS' panel displays 'BodyFunc' as the selected function. The 'Similarity mode' is set to 'Table'. A 'Case Base Values' table is shown, which is highlighted with a red border. The table lists similarity scores for different car body types against a 'Reset' baseline.

	Reset	convertible	coupe	fastback	ro
convertible	1.0	0.0	0.2	0.7	
coupe	0.0	1.0	0.2	0.0	
fastback	0.2	0.2	1.0	0.5	
roadster	0.7	0.0	0.5	1.0	
sedan	0.0	0.7	0.0	0.0	
station_w...	0.0	0.5	0.0	0.0	

Local similarities: Car model

The screenshot displays the Protégé 3.1.1 interface for a project named 'autos'. The 'Similarity Modeling' tab is active, showing the configuration for similarity measure functions. The 'CLASS BROWSER' on the left shows a class hierarchy with ':THING' as the root, followed by ':SYSTEM-CLASS', and then 'Car' and 'Soundsystem'. The 'SLOT BROWSER' on the left lists various slots: Gas, Power, Model, Doors, ZIP, Sound, Color, Extras, Year, Body, Manufacturer, CCM, Car Code, Price, and Speed. The 'SIMILARITY MEASURE FUNCTIONS' panel shows the 'ModelFunc' function selected. The 'Similarity mode' is set to 'Taxonomy'. The 'Symmetry' is set to 'symmetric'. The 'Inner nodes as values' section has 'yes' selected for both 'query' and 'case'. The 'Semantic of inner nodes' section has 'any_value' selected for both 'query' and 'case'. The 'Semantic of uncertain' section has 'pessimistic' selected for both 'query' and 'case'. The 'Model' slot is expanded in the right pane, showing a hierarchy of car models: 'golf', 'm3', 'm_roads...', 'passat', '3_series [0.5]' (with sub-models: '320i', '323i', '325td', '325tds', '328i', '318i', '316i'), '5_series [0.5]', 'a_class [0.5]', 'c_class [0.5]', 'e_class [0.5]', 'z3_series [0.5]', and 'slk [0.5]'. The 'Model' slot is highlighted in blue.

Local similarities: Car model



Local similarities: Cylinder capacity

The screenshot shows the Protégé 3.1.1 interface with the Similarity Modeling tool active. The Class Browser on the left shows the project 'autos' with a class hierarchy including :THING, :SYSTEM-CLASS, Car, and Soundsystem. The Slot Browser shows a hierarchy of slots including Gas, Power, Model, Doors, ZIP, Sound, Color, Extras, Year, Body, Manufacturer, CCM, Car Code, and Price. The Similarity Measure Functions panel shows the CCMFunc function selected, with buttons for New, Duplicate, Delete, and Active. The Similarity mode is set to Advanced, and Symmetry is set to asymmetric. The Basic Similarity Points table shows:

Distance	Similarity
Min	0.8
0	1.0
Max	0.0

The Additional Similarity Points table is empty. The graph at the bottom shows a similarity function for 'query < case' and 'case < query'. The x-axis represents distance from -5000 to 5000, and the y-axis represents similarity from 0.0 to 1.0. The function is a piecewise linear graph with vertices at (-5000, 0.8), (0, 1.0), and (5000, 0.0).

Local similarities: Cylinder capacity

The screenshot displays the Protégé 3.1.1 interface for Similarity Modeling. The main window is titled "autos Protégé 3.1.1" and shows the "Similarity Modeling" tab. The "CLASS BROWSER" on the left shows the project "autos" with a class hierarchy including :THING, :SYSTEM-CLASS, Car, and Soundsystem. The "SLOT BROWSER" on the left shows a slot hierarchy including Gas, Power, Model, Doors, ZIP, Sound, Color, Extras, Year, Body, Manufacturer, CCM, Car Code, and Price. The "SIMILARITY MEASURE FUNCTIONS" panel shows the "CCMFunc" function selected. The "Similarity mode" is set to "Advanced" and "Symmetry" is set to "asymmetric". The "Basic Similarity Points" table is as follows:

Distance	Similarity
Min	0.8
0	1.0
Max	0.0

The "Additional Similarity Points" table is empty. A graph at the bottom shows the similarity function for "query < case" (left side) and "case < query" (right side). The x-axis represents distance from -5000 to 5000, and the y-axis represents similarity from 0.0 to 1.0. The function is a trapezoid with a peak similarity of 1.0 at distance 0. The left side (query < case) is a horizontal line at similarity 0.8 from distance -5000 to -3761, then a line from (-3761, 0.8) to (0, 1.0). The right side (case < query) is a line from (0, 1.0) to (5000, 0.0).

myCBR Retrieval Tab

DETAILS AND QUERY

Car

<input type="button" value="Reset"/>	Query	731 1 [1,00]	128 1 [0,99]	554 1 [0,99]
--------------------------------------	-------	--------------------	--------------------	--------------------

Gas diesel
Power 176
Model e_300_diesel
Doors 4
ZIP 3
Color yellow
+ Extras Navigation
Year 1996.0
Body sedan
Manufact... mercedes-benz
CCM 3000
Car Code 100
Price 58499
Speed 224
Miles 18146
Box_amo... <<_ UNDEFINED _>>
Receiver_... <<_ UNDEFINED _>>
Bass <<_ UNDEFINED _>>
Box_Brand <<_ UNDEFINED _>>
+ CDPlayer <<_ UNDEFINED _>>

+ CDPlayer <<_ UNDEFINED _>>
Box_Brand <<_ UNDEFINED _>>
Box_amo... <<_ UNDEFINED _>>

Query

Reset	Query
Gas	diesel
Power	176
Model	e_300_diesel
Doors	4
ZIP	3
Color	yellow
+ Extras	Navigation
Year	1996.0
Body	sedan
Manufact...	mercedes-benz
CCM	3000
Car Code	100
Price	58499
Speed	224
Miles	18146
Box_amo...	<<_ UNDEFINED _>>
Receiver_...	<<_ UNDEFINED _>>
Bass	<<_ UNDEFINED _>>
Box_Brand	<<_ UNDEFINED _>>
+ CDPlayer	<<_ UNDEFINED _>>
+ CDPlayer	<<_ UNDEFINED _>>

Retrieval results for case 100

autos Protégé 3.1.1 (file:/Users/roth/Documents/workspace/mycbr/distribution/samples/auto_set/autos.pprj, Protégé Files (.pont and .pins))

Classes Slots Forms Instances Similarity Modeling **CBR Retrieval**

DETAILS AND QUERY

Car < >

Reset	Query	100 1 [1,00]	881 2 [0,96]	22 3 [0,89]
Gas	diesel	diesel	diesel	diesel
Power	176	176	176	176
Model	e_300_diesel	e_300_diesel	e_300_diesel	e_300_diesel
Doors	4	4	5	5
ZIP	3	3	5	2
Color	yellow	yellow	yellow	green
+ Extras	Navigation	Navigation	<<_ UNDEFINED _>>	Navigation
Year	1996.0	1996.0	1995.0	1996.0
Body	sedan	sedan	station_wagon	station_wagon
Manufact...	mercedes-benz	mercedes-benz	mercedes-benz	mercedes-benz
CCM	3000	3000	3000	3000
Car Code	100	100	881	22
Price	58499	58499	46499	44099
Speed	224	224	224	224
Miles	18146	18146	45604	51851
Box_amo...	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>
Receiver...	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>
Bass	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>
Box_Brand	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>
+CDPlayer	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>

QUERY RESULTS

r	Case Name	Sim
1	100	[1,00]
2	881	[0,96]
3	22	[0,89]
4	54	[0,89]
5	466	[0,88]
6	18	[0,88]
7	747	[0,88]
8	122	[0,88]
9	929	[0,88]
10	513	[0,88]
11	876	[0,88]
12	617	[0,86]
13	401	[0,85]
14	608	[0,85]
15	680	[0,85]
16	883	[0,84]
17	82	[0,84]
18	331	[0,84]
19	143	[0,84]
20	267	[0,84]
21	727	[0,84]
22	577	[0,84]

Start: 4:36:03
Finish: 4:36:05
Duration: 2,096 sec

Retrieval results for case 100

The screenshot shows the Protégé 3.1.1 CBR Retrieval interface. The main window displays a comparison of the query case (Case 100) with three retrieved cases (Cases 881, 22, and 22). A red box highlights the query details for Case 100. The 'QUERY RESULTS' panel on the right lists 22 retrieved cases with their similarity scores. The 'Start Retrieval' button is visible in the top right of the main window.

DETAILS AND QUERY

Car [dropdown] [Reset Query] [Query from Case] [Start Retrieval] [Navigation]

Query	100	881	22
Reset	1	2	3
	[1,00]	[0,96]	[0,89]
Gas	diesel	diesel	diesel
Power	176	176	176
Model	e_300_diesel	e_300_diesel	e_300_diesel
Doors	4	4	5
ZIP	3	3	2
Color	yellow	yellow	green
Extras	Navigation	<<_ UNDEFINED _>>	Navigation
Year	1996.0	1995.0	1996.0
Body	sedan	station_wagon	station_wagon
Manufact.	mercedes-benz	mercedes-benz	mercedes-benz
CCM	3000	3000	3000
Car Code	100	81	22
Price	58499	6499	44099
Speed	224	24	224
Miles	18146	5604	51851
Box_amo.	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>
Receiver.	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>
Bass	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>
Box_Brand	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>
+CDPlayer	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>

QUERY RESULTS

r	Case Name	Sim
1	100	[1,00]
2	881	[0,96]
3	22	[0,89]
4	54	[0,89]
5	466	[0,88]
6	18	[0,88]
7	747	[0,88]
8	122	[0,88]
9	929	[0,88]
10	513	[0,88]
11	876	[0,88]
12	617	[0,86]
13	401	[0,85]
14	608	[0,85]
15	680	[0,85]
16	883	[0,84]
17	82	[0,84]
18	331	[0,84]
19	143	[0,84]
20	267	[0,84]
21	727	[0,84]
22	577	[0,84]

Start: 4:36:03
Finish: 4:36:05
Duration: 2,096 sec
[Show Statistics]

Retrieval results for case 100

autos Protégé 3.1.1 (file:/Users/roth/Documents/workspace/mycbr/distribution/samples/auto_set/autos.pprj, Protégé Files (.pont and .pins))

Classes Slots Forms Instances Similarity Modeling **CBR Retrieval**

DETAILS AND QUERY

Car < >

Query

	100	881	22
Gas	diesel	diesel	diesel
Power	176	176	176
Model	e_300_diesel	e_300_diesel	e_300_diesel
Doors	4	5	5
ZIP	3	5	2
Color	yellow	yellow	green
Extras	Navigation	<<_ UNDEFINED _>>	Navigation
Year	1996.0	1995.0	1996.0
Body	sedan	station_wagon	station_wagon
Manufact...	mercedes-benz	mercedes-benz	mercedes-benz
CCM	3000	3000	3000
Car Code	100	881	22
Price	58499	46499	44099
Speed	224	224	224
Miles	18146	45604	51851
Box_amo...	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>
Receiver...	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>
Bass	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>
Box_Brand	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>
CDPlayer	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>

QUERY RESULTS

r	Case Name	Sim
1	100	[1,00]
2	881	[0,96]
3	22	[0,89]
4	54	[0,89]
5	466	[0,88]
6	18	[0,88]
7	747	[0,88]
8	122	[0,88]
9	929	[0,88]
10	513	[0,88]
11	876	[0,88]
12	617	[0,86]
13	401	[0,85]
14	608	[0,85]
15	680	[0,85]
16	883	[0,84]
17	82	[0,84]
18	331	[0,84]
19	143	[0,84]
20	267	[0,84]
21	727	[0,84]
22	577	[0,84]

Start: 4:36:03
Finish: 4:36:05
Duration: 2,096 sec

Ranking of cases

QUERY RESULTS		
r	Case Name	Sim
1	100	[1,00]
2	881	[0,96]
3	22	[0,89]
4	54	[0,89]
5	466	[0,88]
6	18	[0,88]
7	747	[0,88]
8	122	[0,88]
9	929	[0,88]
10	513	[0,88]
11	876	[0,88]
12	617	[0,86]
13	401	[0,85]
14	608	[0,85]
15	680	[0,85]
16	883	[0,84]
17	82	[0,84]
18	331	[0,84]
19	143	[0,84]
20	267	[0,84]
21	727	[0,84]
22	577	[0,84]
55	211	[0,84]
57	151	[0,84]
59	591	[0,84]

Retrieval results for case 100

Reset	Query	1 [1,00]	2 [0,96]	3 [0,89]
Gas	diesel	diesel	diesel	diesel
Power	176	176	176	176
Model	e_300_diesel	e_300_diesel	e_300_diesel	e_300_diesel
Doors	4	4	5	5
ZIP	3	3	5	2
Color	yellow	yellow	yellow	green
+ Extras	Navigation	Navigation	<<_ UNDEFINED _>>	Navigation
Year	1996.0	1996.0	1995.0	1996.0
Body	sedan	sedan	station_wagon	station_wagon
Manufact...	mercedes-benz	mercedes-benz	mercedes-benz	mercedes-benz
CCM	3000	3000	3000	3000
Car Code	100	100	881	22
Price	58499	58499	46499	44099
Speed	224	224	224	224
Miles	18146	18146	45604	51851
Box_amo...	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>
Receiver_...	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>
Bass	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>
Box_Brand	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>
+ CDPlayer	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>
+ CDPlayer	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>

Retrieval results for case 100

Backward explanations of retrieval results via tooltips, for example:

- local similarity values
- used amalgamation function
- information on structural similarity (class hierarchy)

Reset	Query	1	[1,00]
Gas	diesel	diesel	diesel
Power	176	176	176
Model	e_300_diesel	e_300_diesel	e_300
Doors	4	4	5
ZIP	3	3	5
Color	yellow	yellow	yellow
+ Extras	Navigation	Navigation	<<_
Year	1996.0	1996.0	1995
Body	sedan	sedan	station
Manufact...	mercedes-benz	mercedes-benz	mercedes-benz
CCM	3000	3000	3000
Car Code	100	100	881
Price	58499	58499	46499
Speed	224	224	224
Miles	18146	18146	45604
Box_amo...	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>
Receiver_...	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>
Bass	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>
Box_Brand	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>
+ CDPlayer	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>
+ CDPlayer	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>	<<_ UNDEFINED _>>

Explanation-based
similarity measure modelling support

Goals

- ✦ Address questions of knowledge modeling from an explanation point of view
- ✦ Provide forward explanations for different slot types
- ✦ Give feedback on cases

Feedback from cases

autos Protégé 3.1.1 (file:/Users/roth/Documents/workspace/mycbr/distribution/samples/auto_set/autos.pprj, Protégé Files (.pont and .pins))

Classes Slots Forms Instances Similarity Modeling CBR Retrieval

CLASS BROWSER
For Project: autos
Class Hierarchy
:THING
:SYSTEM-CLASS
Car
Soundsystem

SLOT BROWSER
For Project: autos
Slot Hierarchy
Year
Doors
Color
Extras
Model
Miles
Power
Speed
Body
Sound
Car Code
CCM
Manufacturer
ZIP
Gas

SIMILARITY MEASURE FUNCTIONS
Available functions
CarFunc
New Duplicate
Delete Active

Attributes (Slots):

attribute	discriminant	weight	comment
Body	100%	<input checked="" type="checkbox"/>	1
CCM	100%	<input checked="" type="checkbox"/>	1
Car Code	100%	<input type="checkbox"/>	0
Color	100%	<input checked="" type="checkbox"/>	1
Doors	100%	<input checked="" type="checkbox"/>	1
Gas	100%	<input checked="" type="checkbox"/>	1
Manufacturer	100%	<input checked="" type="checkbox"/>	1
Miles	100%	<input checked="" type="checkbox"/>	1
Model	100%	<input checked="" type="checkbox"/>	1
Power	100%	<input checked="" type="checkbox"/>	1
Price	100%	<input checked="" type="checkbox"/>	1
Speed	100%	<input checked="" type="checkbox"/>	1
Year	100%	<input checked="" type="checkbox"/>	1
ZIP	100%	<input type="checkbox"/>	0
Extras	154%	<input checked="" type="checkbox"/>	1
Sound	0%	<input checked="" type="checkbox"/>	1

cannot inherit! Weighted Sum Minimum
 Euclidean Maximum

Feedback from cases

The screenshot shows the Protégé 3.1.1 interface with the Similarity Modeling window open. The window title is "autos Protégé 3.1.1 (file:/Users/roth/Documents/workspace/mycbr/distribution/samples/auto_set/autos.pprj, Protégé Files (.pont and .pins))". The Similarity Modeling window has tabs for "Classes", "Slots", "Forms", "Instances", "Similarity Modeling", and "CBR Retrieval". The "Similarity Modeling" tab is active, showing a list of "Available functions" with "CarFunc" selected. Below this is a table titled "Attributes (Slots):" with columns for "attribute", "discriminant", "weight", and "comment". The table is highlighted with a red border. The "attribute" column lists various car features, the "discriminant" column shows checkboxes, the "weight" column shows percentages, and the "comment" column shows binary values. At the bottom of the window, there are radio buttons for "Weighted Sum" (selected), "Euclidean", "Minimum", and "Maximum".

attribute	discriminant	weight	comment
Body	<input checked="" type="checkbox"/>	100%	1
CCM	<input checked="" type="checkbox"/>	100%	1
Car Code	<input type="checkbox"/>	100%	0
Color	<input checked="" type="checkbox"/>	100%	1
Doors	<input checked="" type="checkbox"/>	100%	1
Gas	<input checked="" type="checkbox"/>	100%	1
Manufacturer	<input checked="" type="checkbox"/>	100%	1
Miles	<input checked="" type="checkbox"/>	100%	1
Model	<input checked="" type="checkbox"/>	100%	1
Power	<input checked="" type="checkbox"/>	100%	1
Price	<input checked="" type="checkbox"/>	100%	0
Speed	<input checked="" type="checkbox"/>	100%	1
Year	<input checked="" type="checkbox"/>	100%	1
ZIP	<input type="checkbox"/>	100%	
Extras	<input checked="" type="checkbox"/>	154%	
Sound	<input checked="" type="checkbox"/>	0%	

- How many cases have values for the given slot?

Feedback from cases

The screenshot shows the Protégé 3.1.1 interface with the 'Similarity Modeling' tab selected. The 'SIMILARITY MEASURE FUNCTIONS' window is open, showing a table of attributes and discriminants for the 'CarFunc' function. A red box highlights the table, and a yellow arrow points to the 'Sound' slot which has 0% discriminant.

attribute	discriminant	weight	comment
Body	100%	<input checked="" type="checkbox"/>	1
CCM	100%	<input checked="" type="checkbox"/>	1
Car Code	100%	<input type="checkbox"/>	0
Color	100%	<input checked="" type="checkbox"/>	1
Doors	100%	<input checked="" type="checkbox"/>	1
Gas	100%	<input checked="" type="checkbox"/>	1
Manufacturer	100%	<input checked="" type="checkbox"/>	1
Miles	100%	<input checked="" type="checkbox"/>	1
Model	100%	<input checked="" type="checkbox"/>	1
Power	100%	<input checked="" type="checkbox"/>	1
Price	100%	<input checked="" type="checkbox"/>	0
Speed	100%	<input checked="" type="checkbox"/>	1
Year	100%	<input checked="" type="checkbox"/>	1
ZIP	100%	<input checked="" type="checkbox"/>	
Extras	154%	<input checked="" type="checkbox"/>	
Sound	0%	<input checked="" type="checkbox"/>	

- How many cases have values for the given slot?
- No use in spending time on a similarity function for slot „Sound“!

Distribution of values

CLASS BROWSER
For Project: autos

Class Hierarchy

- :THING
 - :SYSTEM-CLASS
 - Car
 - Soundsystem

SLOT BROWSER
For Project: autos

Slot Hierarchy

- Year
- Doors
- Color
- Extras
- Model
- Miles
- Power
- Speed
- Body
- Sound
- Car Code
- CCM

SIMILARITY MEASURE FUNCTIONS

Available functions

BodyFunc

New Duplicate

Delete Active

Similarity mode: Table

Symmetry: symmetric asymmetric

Case Base Values

Reset	convertible	coupe	fastback	roadster	sedan	station_wagon
con...	7% 1.0	0.0	0.2	0.7	0.0	0.0
coupe	5% 0.0	1.0	0.2	0.0	0.7	0.5
fast...	12% 0.2	0.2	1.0	0.5	0.0	0.0
road...	4% 0.7	0.0	0.5	1.0	0.0	0.0
sedan	37% 0.0	0.7	0.0	0.0	1.0	0.8
stati...	33% 0.0	0.5	0.0	0.0	0.8	1.0

Query Values

Explanations

- How often is the respective symbol used in the case base?

Distribution of values

The screenshot shows the Protégé 3.1.1 interface with the Similarity Measure Editor active. The 'SIMILARITY MEASURE FUNCTIONS' panel is open, showing 'BodyFunc' as the selected function. The 'Similarity mode' is set to 'Table' and 'Symmetry' is set to 'symmetric'. A 'Case Base Values' table is displayed, showing similarity values between different car body styles. The table is highlighted with a red border.

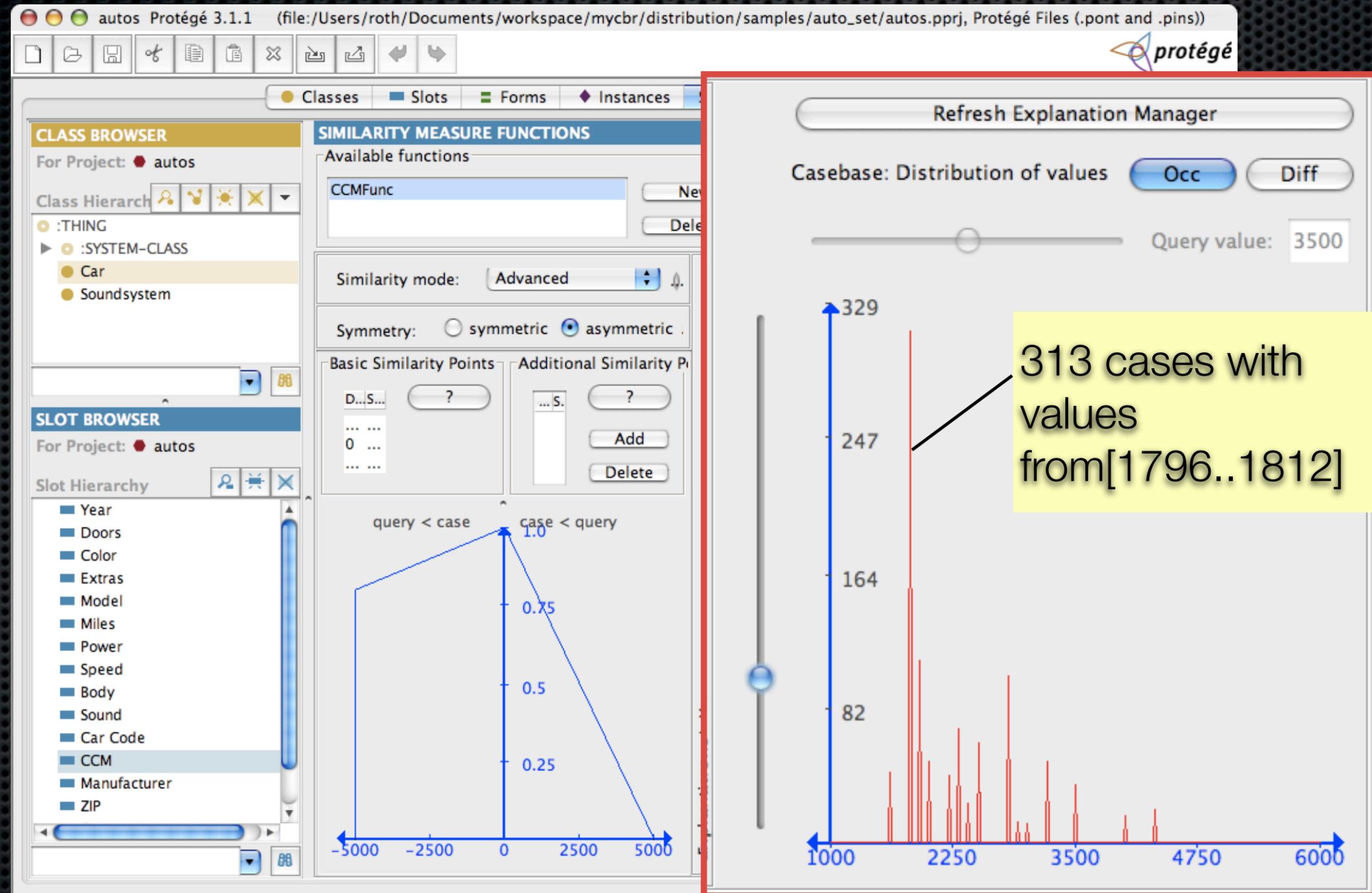
Reset	convertible	coupe	fastback	roadster	sedan	station_wagon
con...	7% 1.0	0.0	0.2	0.7	0.0	0.0
coupe	5% 0.0	1.0	0.2	0.0	0.7	0.5
fast...	12% 0.2	0.2	1.0	0.5	0.0	0.0
road...	4% 0.7	0.0	0.5	1.0	0.0	0.0
sedan	37% 0.0	0.7	0.0	0.0	1.0	0.8
stati...	33% 0.0	0.5	0.0	0.0	0.8	1.0

- How often is the respective symbol used in the case base?

Distribution of case values

The screenshot displays the Protégé 3.1.1 interface with the 'Similarity Modeling' tab selected. The 'CLASS BROWSER' on the left shows a hierarchy for the 'autos' project, including classes like Car and Soundsystem. The 'SLOT BROWSER' lists various attributes such as Year, Doors, Color, and CCM. The 'SIMILARITY MEASURE FUNCTIONS' panel shows the 'CCMFunc' function selected. The 'Similarity mode' is set to 'Advanced' and 'Symmetry' is set to 'asymmetric'. The 'Basic Similarity Points' and 'Additional Similarity Points' sections allow for defining similarity criteria. A graph shows a similarity function with a peak at 0, where 'query < case' and 'case < query' both result in a similarity of 1.0. The 'Casebase: Distribution of values' section shows a histogram of values with a 'Query value' of 3500. The histogram has a y-axis with values 82, 164, 247, and 329, and an x-axis with values 1000, 2250, 3500, 4750, and 6000.

Distribution of case values



Distribution of case values

The image shows a screenshot of the Protégé 3.1.1 interface. The main window displays the 'SIMILARITY MEASURE FUNCTIONS' panel, which includes a 'CLASS BROWSER' on the left showing a hierarchy for the 'autos' project (Thing, System-Class, Car, Soundsystem). The 'SIMILARITY MEASURE FUNCTIONS' panel shows 'CCMFunc' selected, with 'Similarity mode' set to 'Advanced' and 'Symmetry' set to 'asymmetric'. A 'Refresh Explanation Manager' dialog is open in the foreground, showing 'Casebase: Distribution of values' with 'Occ' selected and a 'Query value' of 3500. A histogram in the background shows the distribution of case values for the CCM slot, with a peak at 329 and a range from 1000 to 6000. A red banner with the text 'Counter example!' is overlaid on the histogram.

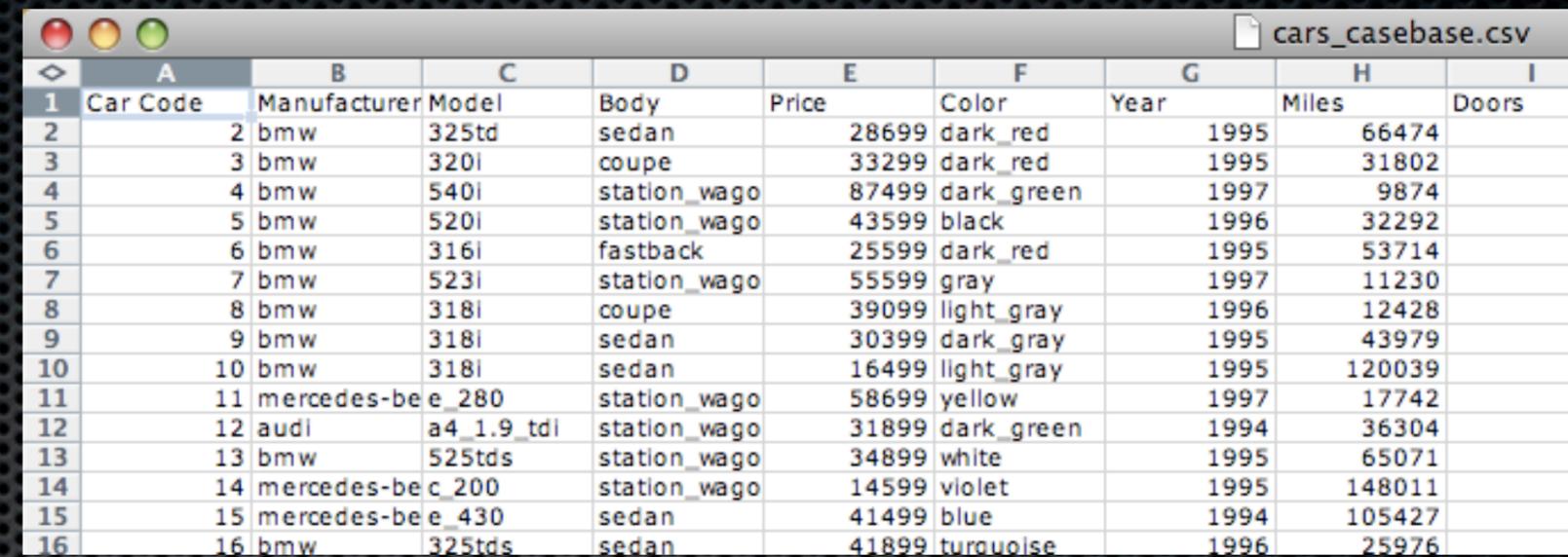
Counter example!

Refresh Explanation Manager
Casebase: Distribution of values Occ Diff
Query value: 3500
329
164
82
[1796..1812]
1000 2250 3500 4750 6000

Status and plans

- ✦ Daniel Bahls (graduate student) programmed most of *myCBR*.
 - works on a first prototype for basic similarity measure modeling support (project thesis)
 - presented a student poster on myCBR and explanations at AAI-07 in Vancouver, Canada
- ✦ Follow-up diploma thesis: Design and development of a generic (forward) explanation component.

Generating model from CSV file

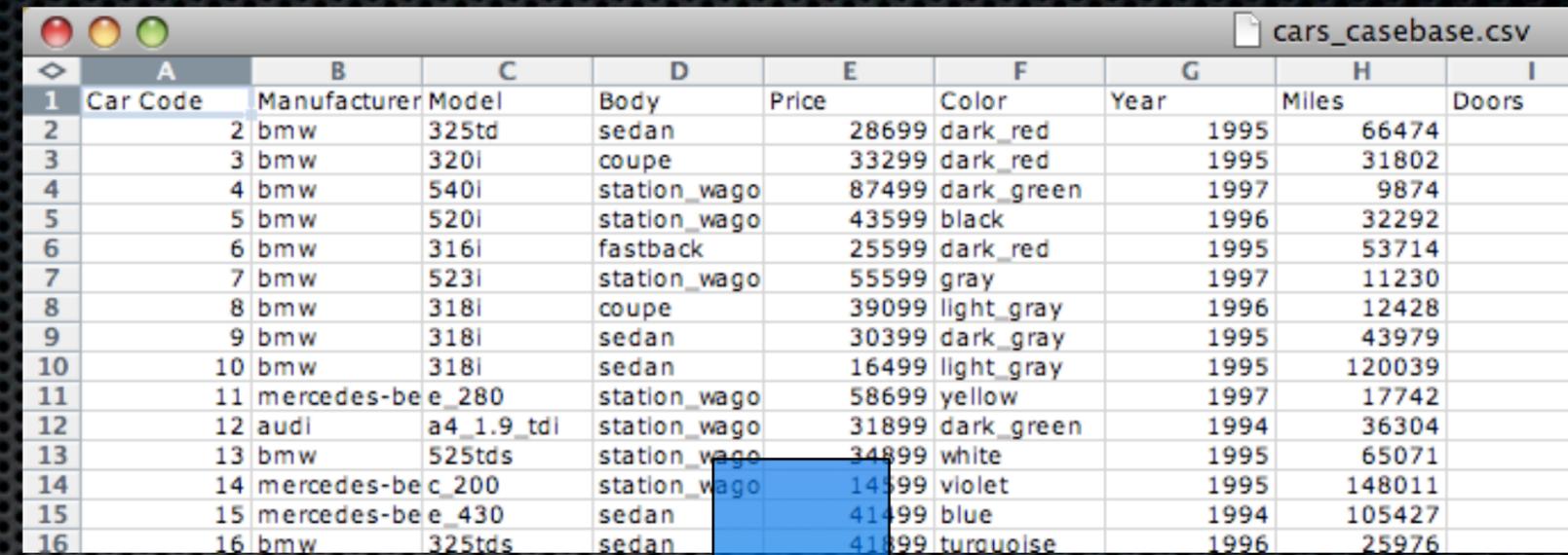


	A	B	C	D	E	F	G	H	I
1	Car Code	Manufacturer	Model	Body	Price	Color	Year	Miles	Doors
2	2	bmw	325td	sedan	28699	dark_red	1995	66474	
3	3	bmw	320i	coupe	33299	dark_red	1995	31802	
4	4	bmw	540i	station_wago	87499	dark_green	1997	9874	
5	5	bmw	520i	station_wago	43599	black	1996	32292	
6	6	bmw	316i	fastback	25599	dark_red	1995	53714	
7	7	bmw	523i	station_wago	55599	gray	1997	11230	
8	8	bmw	318i	coupe	39099	light_gray	1996	12428	
9	9	bmw	318i	sedan	30399	dark_gray	1995	43979	
10	10	bmw	318i	sedan	16499	light_gray	1995	120039	
11	11	mercedes-be	e_280	station_wago	58699	yellow	1997	17742	
12	12	audi	a4_1.9_tdi	station_wago	31899	dark_green	1994	36304	
13	13	bmw	525tds	station_wago	34899	white	1995	65071	
14	14	mercedes-be	c_200	station_wago	14599	violet	1995	148011	
15	15	mercedes-be	e_430	sedan	41499	blue	1994	105427	
16	16	bmw	325tds	sedan	41899	turquoise	1996	25976	

- ✦ Columns become attributes
- ✦ Based on column content myCBR chooses attribute type

Explanations required!

Generating model from CSV file



	A	B	C	D	E	F	G	H	I
1	Car Code	Manufacturer	Model	Body	Price	Color	Year	Miles	Doors
2	2	bmw	325td	sedan	28699	dark_red	1995	66474	
3	3	bmw	320i	coupe	33299	dark_red	1995	31802	
4	4	bmw	540i	station_wago	87499	dark_green	1997	9874	
5	5	bmw	520i	station_wago	43599	black	1996	32292	
6	6	bmw	316i	fastback	25599	dark_red	1995	53714	
7	7	bmw	523i	station_wago	55599	gray	1997	11230	
8	8	bmw	318i	coupe	39099	light_gray	1996	12428	
9	9	bmw	318i	sedan	30399	dark_gray	1995	43979	
10	10	bmw	318i	sedan	16499	light_gray	1995	120039	
11	11	mercedes-be	e_280	station_wago	58699	yellow	1997	17742	
12	12	audi	a4_1.9_tdi	station_wago	31899	dark_green	1994	36304	
13	13	bmw	525tds	station_wago	34899	white	1995	65071	
14	14	mercedes-be	c_200	station_wago	14599	violet	1995	148011	
15	15	mercedes-be	e_430	sedan	41499	blue	1994	105427	
16	16	bmw	325tds	sedan	41899	turquoise	1996	25976	

- ✦ Columns become attributes
- ✦ Based on column content myCBR chooses attribute type

Explanations required!

Generating model from CSV file

- Columns become attributes
- Based on column content myCBR chooses attribute type

Explanations required!

	A	B	C	D	E	F	G	H	I
1	Car Code	Manufacturer	Model	Body	Price	Color	Year	Miles	Doors
2		2	bmw	325td	sedan	28699	dark_red	1995	66474
3		3	bmw	320i	coupe	33299	dark_red	1995	31802
4		4	bmw	540i	station_wago	87499	dark_green	1997	9874
5		5	bmw	520i	station_wago	43599	black	1996	32292
6		6	bmw	316i	fastback	25599	dark_red	1995	53714
7		7	bmw	523i	station_wago	55599	gray	1997	11230
8		8	bmw	318i	coupe	39099	light_gray	1996	12428
9		9	bmw	318i	sedan	30399	dark_gray	1995	43979
10		10	bmw	318i	sedan	16499	light_gray	1995	120039
11		11	mercedes-be	e_280	station_wago	58699	yellow	1997	17742
12		12	audi	a4_1.9_tdi	station_wago	31899	dark_green	1994	36304
13		13	bmw	525tds	station_wago	34899	white	1995	65071
14		14	mercedes-be	c_200	station_wago	14599	violet	1995	148011
15		15	mercedes-be	e_430	sedan	41499	blue	1994	105427
16		16	bmw	325tds	sedan	41899	turquoise	1996	25976

Name	Cardinality	Type	Other Facets
Body	single	Symbol	allowed-values={convertible, coupe, fastback, roadster, sedan,...
Car Code	single	Integer	minimum=0, maximum=10000000
CCM	single	Integer	minimum=1000, maximum=6000
Color	single	Symbol	allowed-values={anthracite, black, blue, dark_blue, dark_gray, ...}
Doors	single	Integer	minimum=2, maximum=7
Extras	multiple	Symbol	allowed-values={ABS, ESP, Navigation}
Gas	single	Symbol	allowed-values={diesel, gasoline}
Manufacturer	single	Symbol	allowed-values={audi, bmw, mercedes-benz, vw}
Miles	single	Integer	minimum=0, maximum=1000000
Model	single	Symbol	allowed-values={316i, 318i, 320i, 323i, 325td, 325tds, 328i, 5...}
Power	single	Integer	minimum=10, maximum=1000
Price	single	Integer	minimum=1, maximum=1000000
Sound	single	Instance of Soundsystem	
Speed	single	Integer	minimum=100, maximum=300
Year	single	Float	minimum=1950.0, maximum=2007.0
ZIP	single	Integer	minimum=0, maximum=9

Kinds of explanations

Conceptual Explanations

- ✦ The goal of conceptual explanations is to build links between unknown and known concepts.

- ✦ Variations:

Definition: “What is a bicycle?” – “A bicycle is a land vehicle with two wheels in line. Pedal cycles are powered by a seated human rider and are a form of human powered vehicle.”

Theoretical proposition: “What is force?” – “Force is Mass times Acceleration.”

Prototypical usage of individual things or actions: “What is a bicycle?” – “The thing, this man crashed with.”

Functional mapping: “What is a bicycle?” – “A bicycle serves as a means of transport.”

Conceptual Explanations



- ✦ The goal of conceptual explanations is to build links between unknown and known concepts.
- ✦ Variations:
 - Definition:** “What is a bicycle?” – “A bicycle is a land vehicle with two wheels in line. Pedal cycles are powered by a seated human rider and are a form of human powered vehicle.”
 - Theoretical proposition:** “What is force?” – “Force is Mass times Acceleration.”
 - Prototypical usage of individual things or actions:** “What is a bicycle?” – “The thing, this man crashed with.”
 - Functional mapping:** “What is a bicycle?” – “A bicycle serves as a means of transport.”

Conceptual Explanations



- ✦ The goal of conceptual explanations is to build links between unknown and known concepts.

- ✦ Variations:

Definition: “What is a bicycle?” – “A bicycle is a vehicle with two wheels in line. Pedal cycles are powered by a seated human and are a form of human powered vehicle.”

Theoretical proposition: “What is force?” – “Force is Mass times Acceleration.”

Prototypical usage of individual things or objects: “What is a bicycle?” – “The thing, this man crashed with.”

Functional mapping: “What is a bicycle?” – “A bicycle serves as a means of transport.”



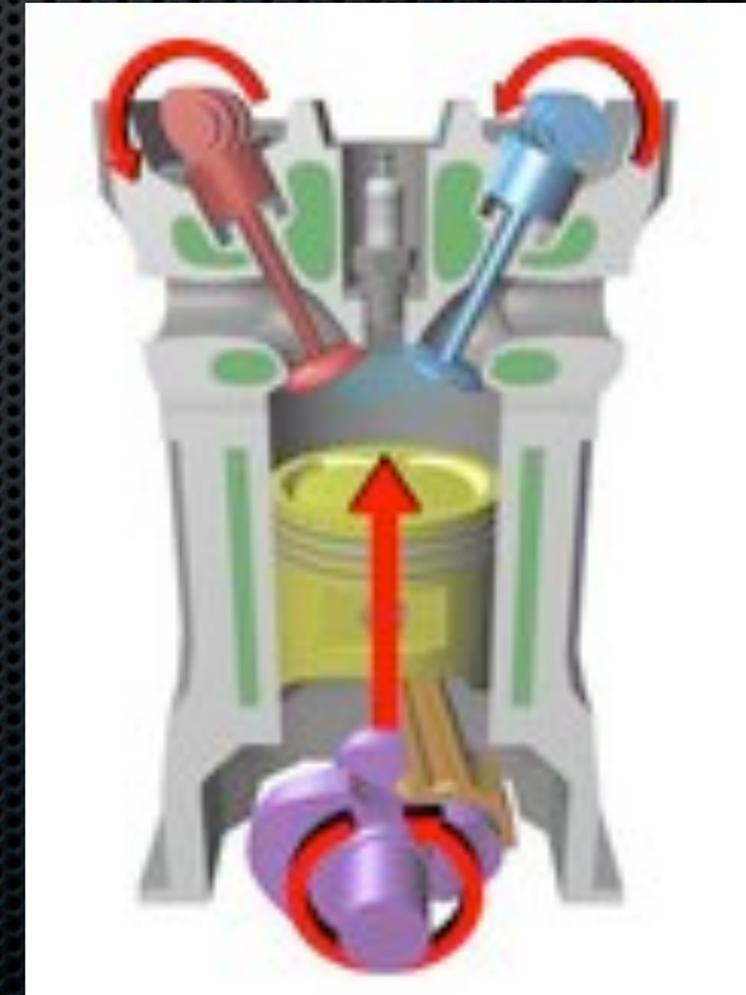
Conceptual Explanations



- ✦ The goal of conceptual explanations is to build links between unknown and known concepts.
- ✦ Variations:
 - Definition:** “What is a bicycle?” – “A bicycle is a land vehicle with two wheels in line. Pedal cycles are powered by a seated human rider and are a form of human powered vehicle.”
 - Theoretical proposition:** “What is force?” – “Force is Mass times Acceleration.”
 - Prototypical usage of individual things or actions:** “What is a bicycle?” – “The thing, this man crashed with.”
 - Functional mapping:** “What is a bicycle?” – “A bicycle serves as a means of transport.”

How-explanations

- ✦ The goal of how-explanations is to help the questioner understand the functionality of an object.
- ✦ Example:
 - “How does a combustion engine work?”
 - “A combustion engine is an engine that operates by burning its fuel.”



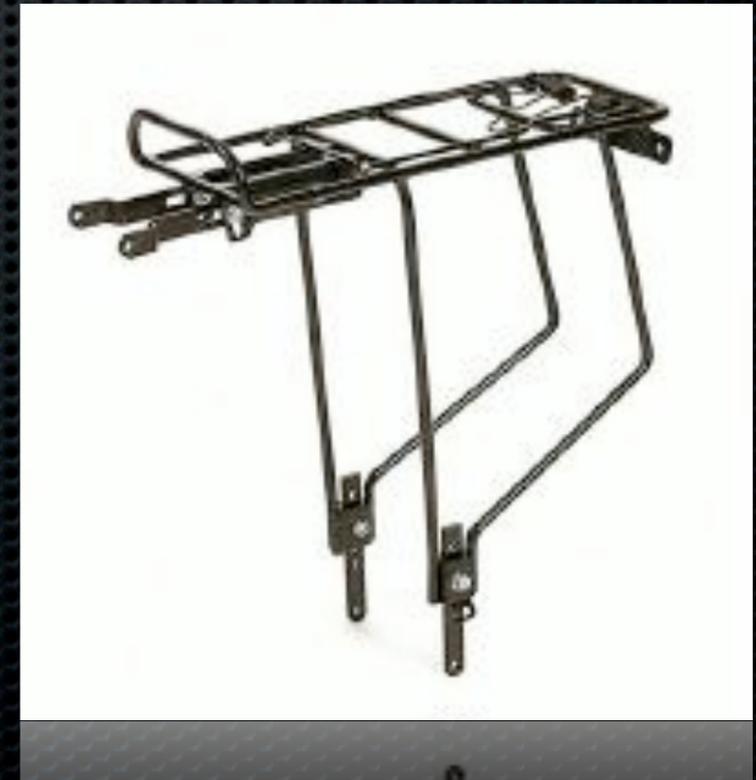
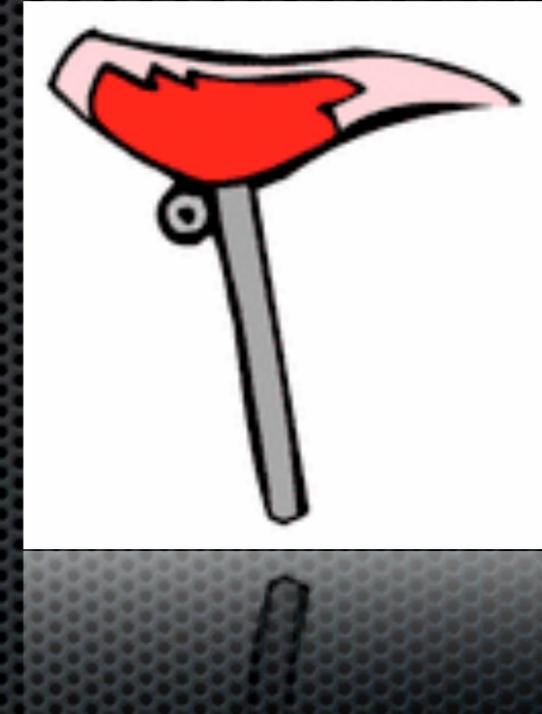
Cognitive explanations

- ✦ Cognitive explanations explain the activities of the system.

- ✦ Examples:

Action explanations: “Why was this seat post selected?” – “For the given price, only one other seat post was available. But this was too short.”

Negative explanations: “Why was no carrier chosen?” – “A carrier is only available for touring bikes. The user did not choose a touring bike.”



Explanation goals



Sørmo, F., Cassens, J., Aamodt, A.: Explanation in Case-Based Reasoning – Perspectives and Goals, 2005.

Explanation goals

- ✦ Transparency
- ✦ Justification
- ✦ Relevance
- ✦ Conceptualization
- ✦ Learning



Sørmo, F., Cassens, J., Aamodt, A.: Explanation in Case-Based Reasoning – Perspectives and Goals, 2005.

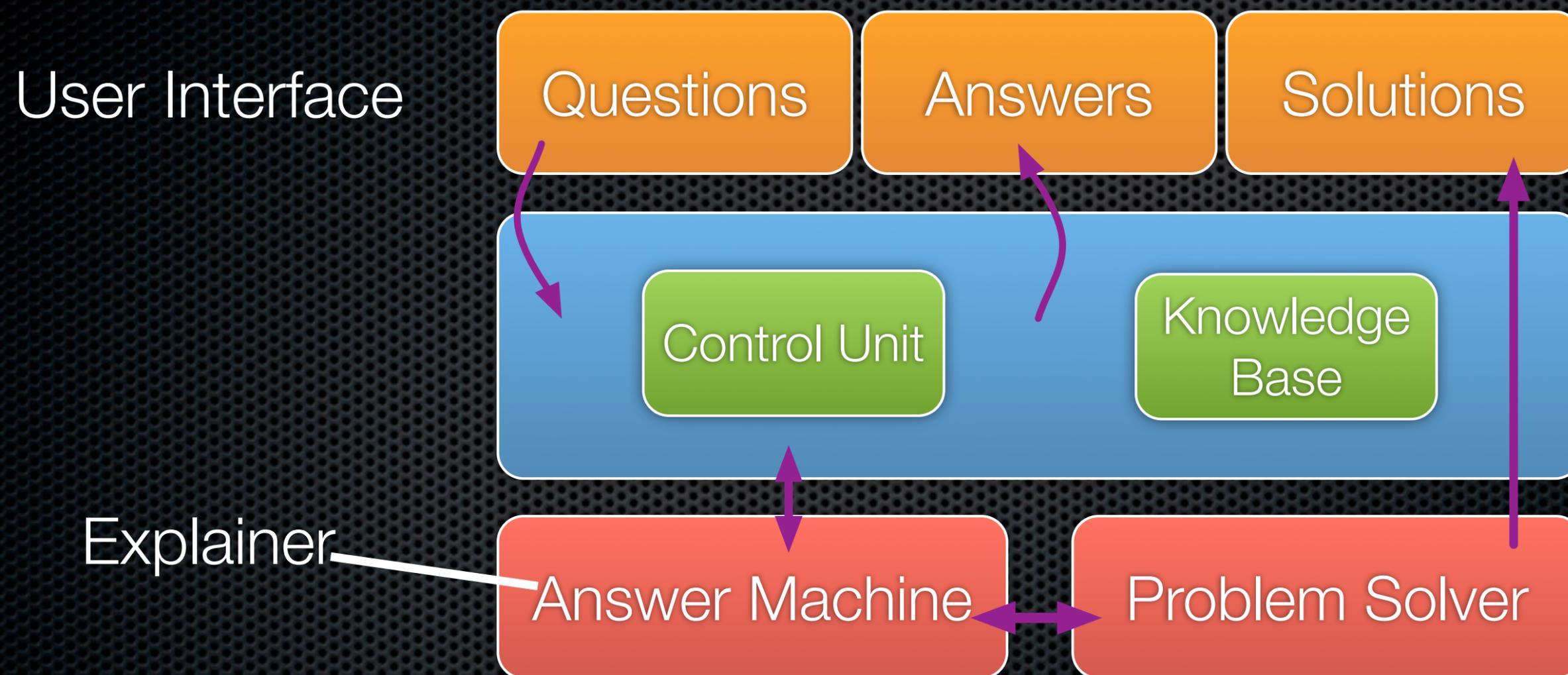
Explanation architecture

An explanation-enabled architecture needs to consider the ...

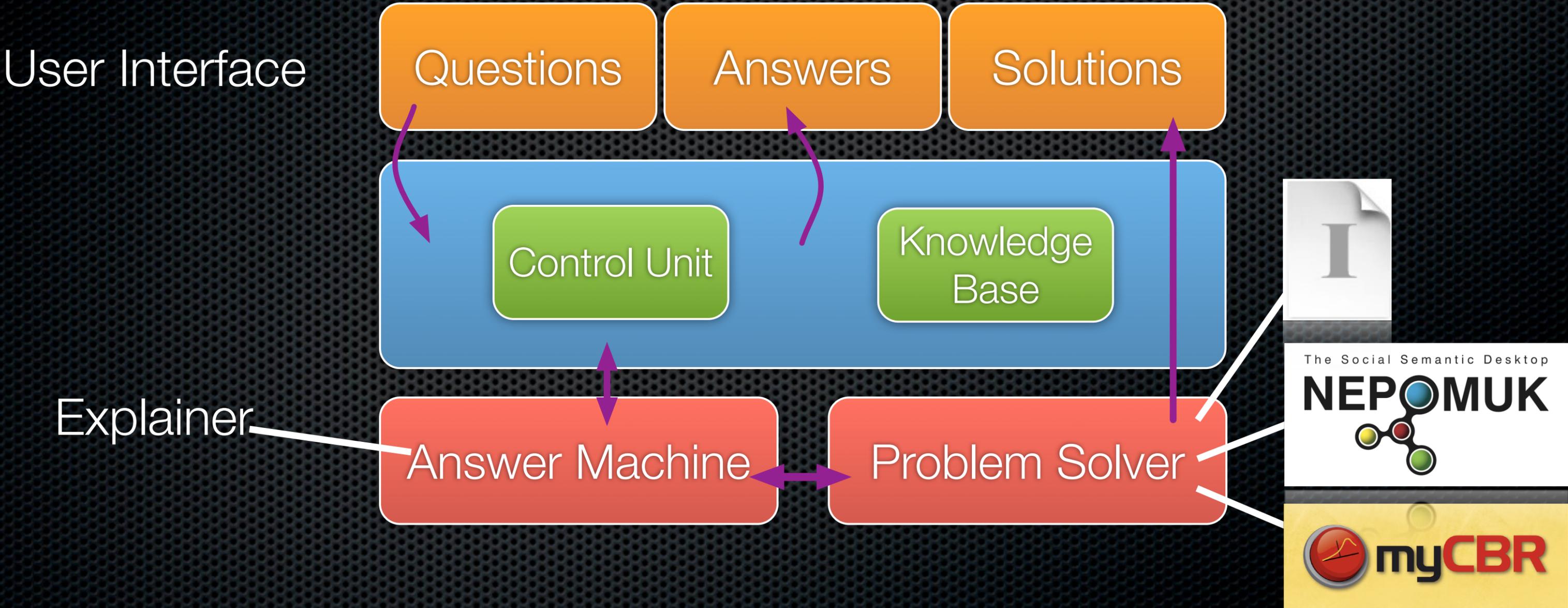
- ✦ Explanation scenario
- ✦ Problem and problem solver in question
- ✦ User and user model
- ✦ Background knowledge for explanation



Explanation-enabled architecture



Explanation-enabled architecture

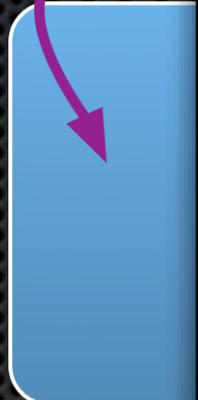


Explanation

Goal reduction in REDUX

User Interface

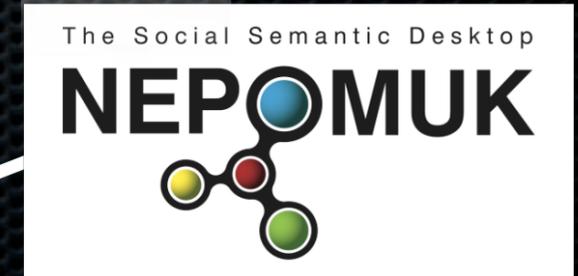
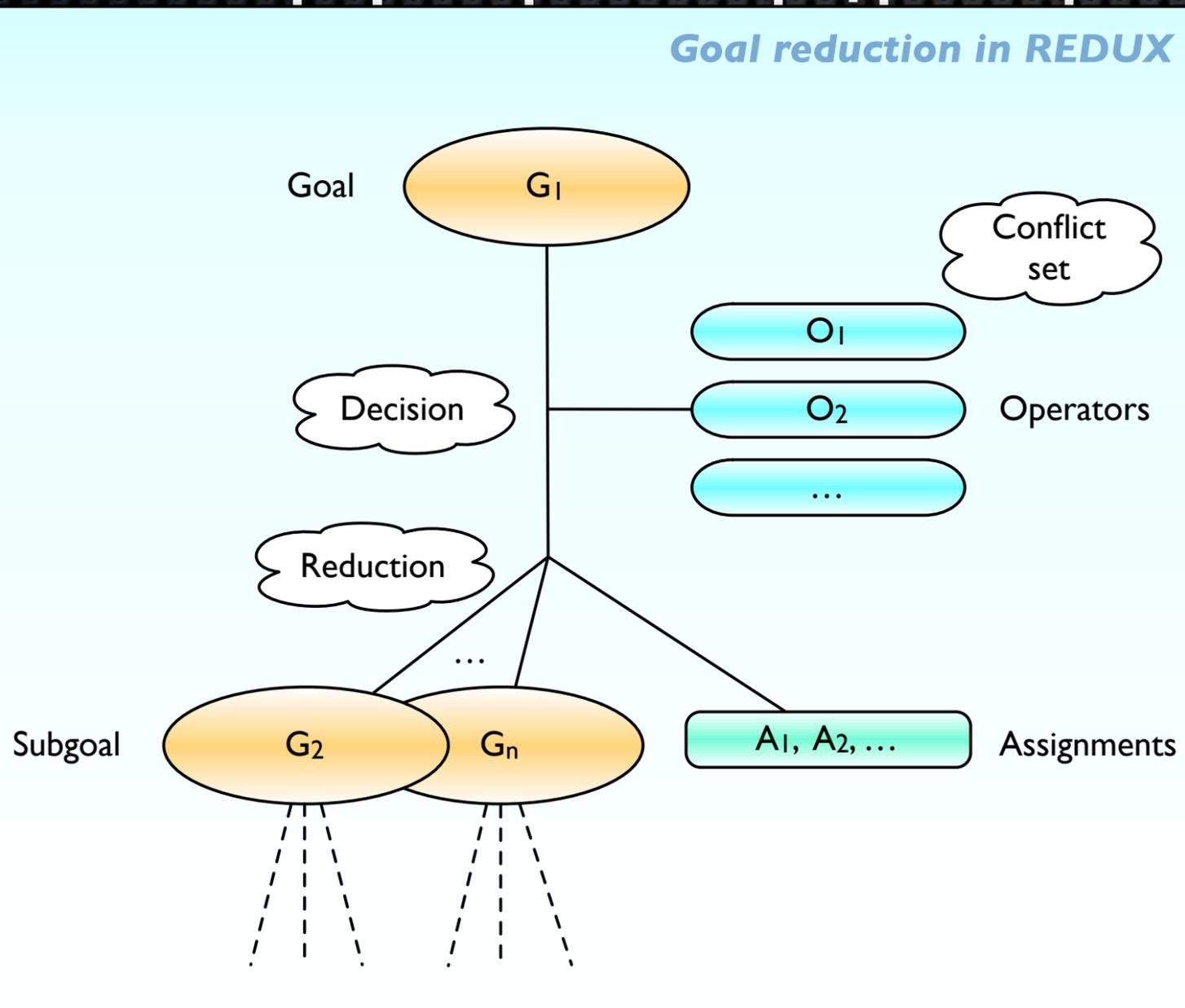
Query



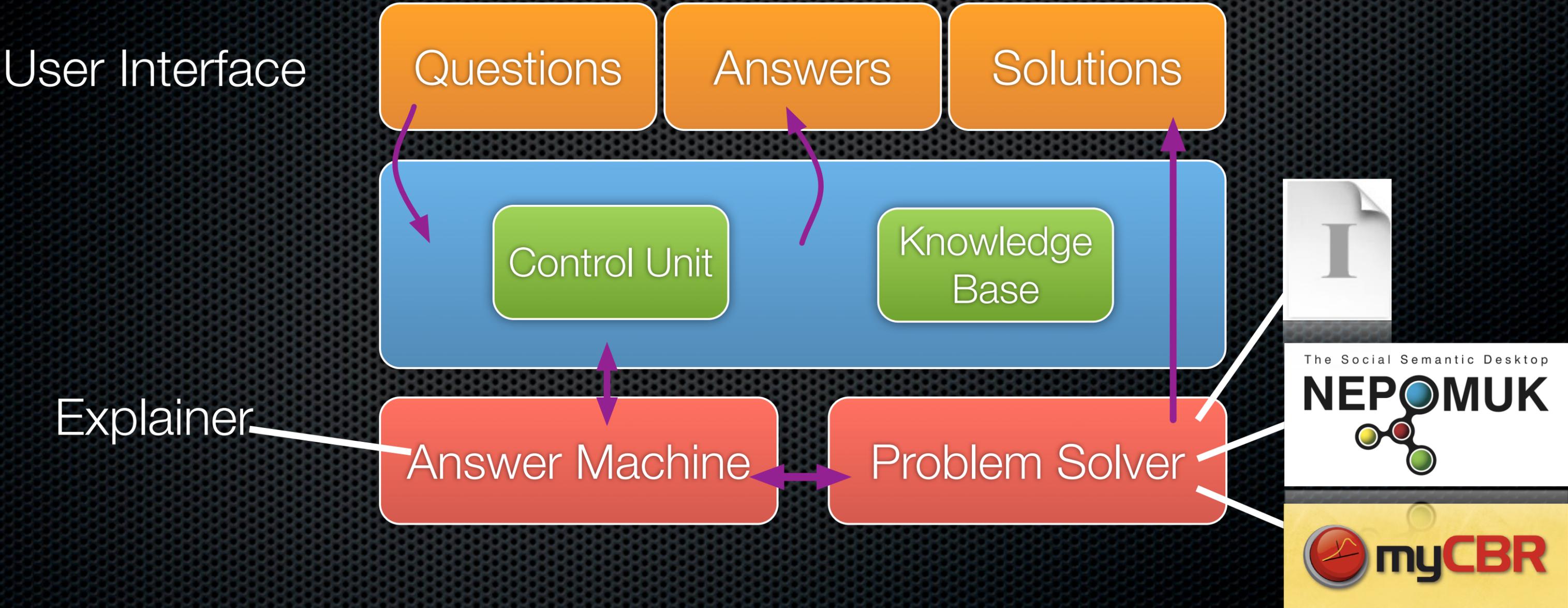
Explainer

Answer Machine

Problem Solver



Explanation-enabled architecture



Summary

- ✦ Basic explanation scenario: user (interface), originator, and explainer
- ✦ Explanations are a special kind of information with cognitive and computational aspects.
- ✦ Examples:
 - Backward explanations in Nepomuk
 - Forward explanations in myCBR
- ✦ Outlook / Goal: Explanation-enabled architecture

On Explanation

—Supporting the Use of
Complex Information Systems—

Thank you!

Thomas Roth-Berghofer
Trippstadter Straße 122
67663 Kaiserslautern, Germany
trb@dfki.de
<http://www.dfki.uni-kl.de/~roth>

