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Collaborative Knowledge Engineering Methods and Tools for System Design

PhD Thesis

Krzysztof Kutt

supervisor: dr hab. inż. Grzegorz J. Nalepa, prof. AGH

Wrocław, 09.05.2018

Overview

Collaborative **Knowledge Engineering**

*an engineering discipline that involves **integrating knowledge into computer systems** in order to solve complex problems normally requiring a high level of human expertise* [47]

COLLABORATIVE KNOWLEDGE ENGINEERING

a joint involvement of participants in the project for a common purpose, although it may result from different motivations

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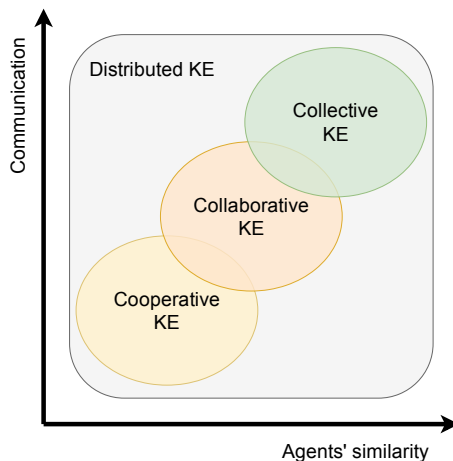
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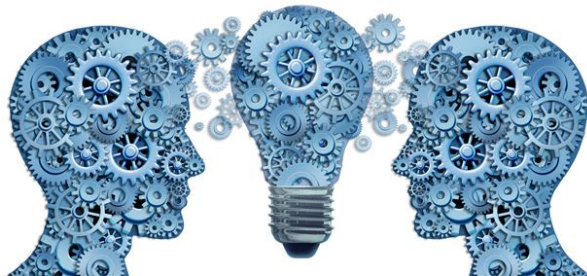
Collaborative Knowledge Engineering

a joint involvement of participants in the project for a common purpose, although it may result from different motivations

COLLABORATIVE KNOWLEDGE ENGINEERING

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WHY DOES IT MATTER?

PARADIGM SHIFT

	Past	**Present**
Design	**KE expert** with domain expert access	KE expert paired with **domain expert(s)**
Population	**KE expert** learns domain	KE and **domain experts** determine the vocabulary
Evolution	**KE expert** heavily involved	KE expert involved in customizing tools that **domain experts** use
Tool Users	Trained in **Computer Science**	Trained in **Domain Sciences**
Application Users	Well understood group	Diverse and evolving group
Reuse	Well thought out	Expect the unexpected

(adapted from [99])

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WHY DOES IT MATTER?

Many use cases: Catalogus Professorum Lipsiensis

WHY DOES IT MATTER?

MANY USE CASES: WIKIPEDIA

WHY DOES IT MATTER?

Many use cases: Wikipedia

- ▶ People want to collaborate!
- ▶ There is a need for tools that work $\rightarrow$ wiki!

But wiki is not good enough.
Knowledge engineering methods can improve it!

WHY DOES IT MATTER?

Many use cases: Wikipedia

- ▶ People want to collaborate!
- ▶ There is a need for tools that work → wiki!

But wiki is not good enough.
Knowledge engineering methods can improve it!

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RDF

Alice

is a friend of

BOB

is interested in

is a

is born on

Person

14 July 1990

Leonardo Da Vinci

was created by

The Mona Lisa

is about

La Joconde à Washington

RDF

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SPARQL

The Mona Lisa
http://www.wikidata.org/entity/Q12418
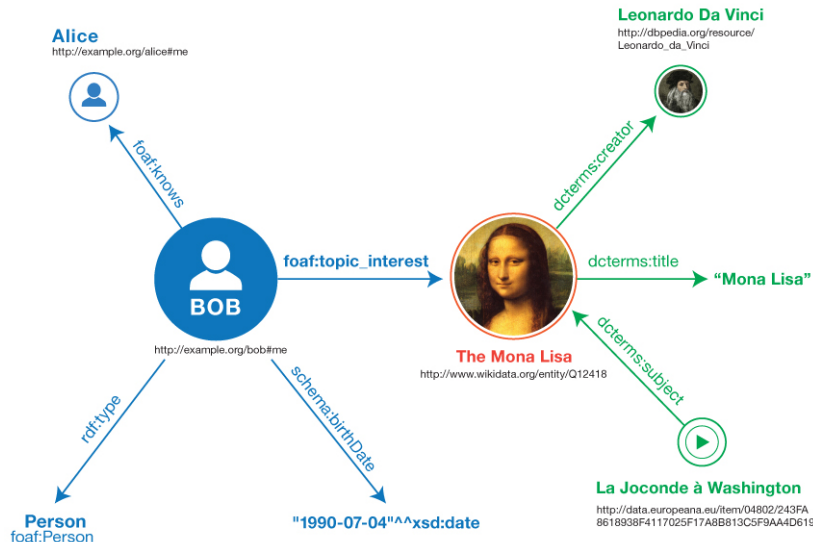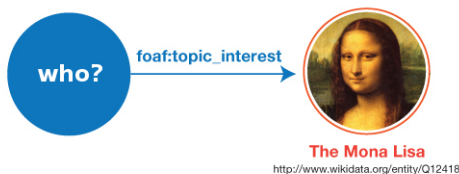
SEMANTIC WIKIS

Wiki + Semantic Web (RDF/SPARQL) = Semantic Wiki

- ▶ 2004: first semantic wiki (Platypus)
- ▶ 2005-2006: "semantic wiki explosion"
- ▶ 2017: Semantic MediaWiki, KnowWE, OntoWiki, Loki

Loki

DokuWiki + Prolog = Loki
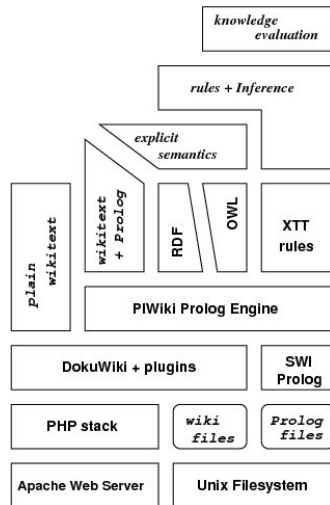
Loki

DokuWiki + Prolog = Loki
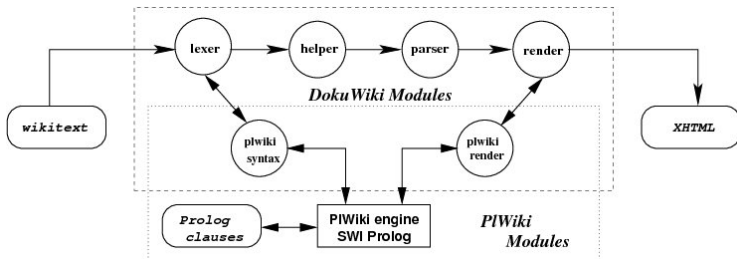
LOKI

Wiki

Title: The Call of Cthulhu

Author: h_p_lovecraft

Publisher: iap

Date: 2009

Language: english

Genre: horror

Pages: 52

Keywords: evenings

Loki

Wiki + annotations

Title: The Call of Cthulhu

Author: h_p_lovecraft

Publisher: iap

Date: 2009

Language: english

Genre: horror

Pages: 52

Keywords: evenings

```
**Title**:  [[title:=The Call of Cthulhu]]
**Author**: [[author::bookstore:author:h_p_lovecraft]]
**Publisher**: [[publisher::bookstore:publisher:iap]]
**Date**: [[date:=2009]]
**Language**:  [[language:=english]]
**Genre**: [[genre::bookstore:genre:horror]]
```

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LOKI

Wiki + annotations = machine transformations

Title: The Call of Cthulhu

Author: h_p_lovecraft

Publisher: iap

Date: 2009

Language: english

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Keywords: evenings

```
**Title**:  [[title:=The Call of Cthulhu]]
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**Publisher**: [[publisher::bookstore:publisher:iap]]
**Date**: [[date:=2009]]
**Language**:  [[language:=english]]
**Genre**: [[genre::bookstore:genre:horror]]
```

Recommendation:

Books by this author:

at_the_mountains_of_madness
the_call_of_cthulhu

▶ mature agile methodology and knowledge maintenance cycle   **Process**

▶ shared repository that supports range of expertise levels
▶ compatibility with existing mainstream system
▶ easily accessible current KB status
▶ adapted to specific project needs

▶ domain knowledge owned by domain users, not a third party
▶ proper representation: easy and powerful

▶ review process
▶ automatic knowledge checking mechanisms
▶ knowledge consistency and credibility
▶ handling of users' conflicts

▶ robust versioning mechanism
▶ support for users' kinds and expectations

▶ usability consideration: experiments and surveys
▶ taking care of compatbility with established practices
▶ incentives: gamification mechanisms?

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► mature agile methodology and knowledge maintenance cycle	**Process**
► shared repository that supports range of expertise levels ► compatibility with existing mainstream system ► easily accessible current KB status ► adapted to specific project needs	**Tools**

► domain knowledge owned by domain users, not a third party

► proper representation: easy and powerful

► review process

► automatic knowledge checking mechanisms

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► handling of users' conflicts

► robust versioning mechanism

► support for users' kinds and expectations

► usability consideration: experiments and surveys

► taking care of compatbility with established practices

► incentives: gamification mechanisms?

▶ mature agile methodology and knowledge maintenance cycle	**Process**

▶ shared repository that supports range of expertise levels	
▶ compatibility with existing mainstream system	
▶ easily accessible current KB status	**Tools**
▶ adapted to specific project needs	

▶ domain knowledge owned by domain users, not a third party	**KRR**
▶ proper representation: easy and powerful	

▶ review process
▶ automatic knowledge checking mechanisms
▶ knowledge consistency and credibility
▶ handling of users' conflicts

▶ robust versioning mechanism
▶ support for users' kinds and expectations

▶ usability consideration: experiments and surveys
▶ taking care of compatbility with established practices
▶ incentives: gamification mechanisms?

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► mature agile methodology and knowledge maintenance cycle	**Process**
► shared repository that supports range of expertise levels ► compatibility with existing mainstream system ► easily accessible current KB status ► adapted to specific project needs	**Tools**
► domain knowledge owned by domain users, not a third party ► proper representation: easy and powerful	**KRR**
► review process ► automatic knowledge checking mechanisms ► knowledge consistency and credibility ► handling of users' conflicts	**Quality management**

► robust versioning mechanism
► support for users' kinds and expectations

► usability consideration: experiments and surveys
► taking care of compatbility with established practices
► incentives: gamification mechanisms?

▶ mature agile methodology and knowledge maintenance cycle	**Process**
▶ shared repository that supports range of expertise levels ▶ compatibility with existing mainstream system ▶ easily accessible current KB status ▶ adapted to specific project needs	**Tools**
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▶ review process ▶ automatic knowledge checking mechanisms ▶ knowledge consistency and credibility ▶ handling of users' conflicts	**Quality management**
▶ robust versioning mechanism ▶ support for users' kinds and expectations	**Change management**

▶ usability consideration: experiments and surveys
▶ taking care of compatbility with established practices
▶ incentives: gamification mechanisms?

▶ mature agile methodology and knowledge maintenance cycle	**Process**
▶ shared repository that supports range of expertise levels ▶ compatibility with existing mainstream system ▶ easily accessible current KB status ▶ adapted to specific project needs	**Tools**
▶ domain knowledge owned by domain users, not a third party ▶ proper representation: easy and powerful	**KRR**
▶ review process ▶ automatic knowledge checking mechanisms ▶ knowledge consistency and credibility ▶ handling of users' conflicts	**Quality management**
▶ robust versioning mechanism ▶ support for users' kinds and expectations	**Change management**
▶ usability consideration: experiments and surveys ▶ taking care of compatbility with established practices ▶ incentives: gamification mechanisms?	**Motivation**

▶ mature agile methodology and knowledge maintenance cycle	**Process**
▶ ~~shared repository that supports range of expertise levels~~ ▶ ~~compatibility with existing mainstream system~~ ▶ ~~easily accessible current KB status~~ ▶ ~~adapted to specific project needs~~	**Tools**
▶ ~~domain knowledge owned by domain users, not a third party~~ ▶ ~~proper representation: easy and powerful~~	**KRR**
▶ review process ▶ automatic knowledge checking mechanisms ▶ knowledge consistency and credibility ▶ handling of users' conflicts	**Quality management**
▶ robust versioning mechanism ▶ support for users' kinds and expectations	**Change management**
▶ usability consideration: experiments and surveys ▶ taking care of compatbility with established practices ▶ incentives: gamification mechanisms?	**Motivation**

KNOWLEDGE ENGINEERING AND SOFTWARE ENGINEERING

Knowledge Engineering	*Software Engineering*
Quality of knowledge?	Quality of software?

KNOWLEDGE ENGINEERING AND SOFTWARE ENGINEERING

Knowledge Engineering	*Software Engineering*
Quality of knowledge? Formal methods	Quality of software?

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KNOWLEDGE ENGINEERING AND SOFTWARE ENGINEERING

Knowledge Engineering	*Software Engineering*
Quality of knowledge?	Quality of software?
~~Formal methods~~	**Unit tests!**

KNOWLEDGE ENGINEERING AND SOFTWARE ENGINEERING

Knowledge Engineering	*Software Engineering*
Quality of knowledge?	Quality of software?
~~Formal methods~~	**Unit tests!**
Methodology/Process?	Methodology/Process?

KNOWLEDGE ENGINEERING AND SOFTWARE ENGINEERING

Knowledge Engineering	*Software Engineering*
Quality of knowledge?	Quality of software?
~~Formal methods~~	**Unit tests!**
Methodology/Process?	Methodology/Process?
	Waterfall or others?

Knowledge Engineering and Software Engineering

Knowledge Engineering	*Software Engineering*
Quality of knowledge?	Quality of software?
~~Formal methods~~	**Unit tests!**
Methodology/Process?	Methodology/Process?
	~~Waterfall or others?~~
	Agile!

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Thesis

Objectives

*The main goals were to **describe a Collaborative Knowledge Engineering process** that provides a general framework for defining roles which should be identified in a group and steps that should be taken in this process, as well as to propose **methods and tools that support the defined CKE process**, leading to the creation of good quality KB in reasonable time, through the means that will be convenient for target users.*

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THESIS

SCOPE

- participants are generally motivated to work,
- development is done in an agile and decentralized way,
- group is working voluntarily (material and formal incentives are not considered),
- CKE process is understood as a creation of KB structured using the **ontology-like** knowledge representation grounded in **RDF** abstract syntax

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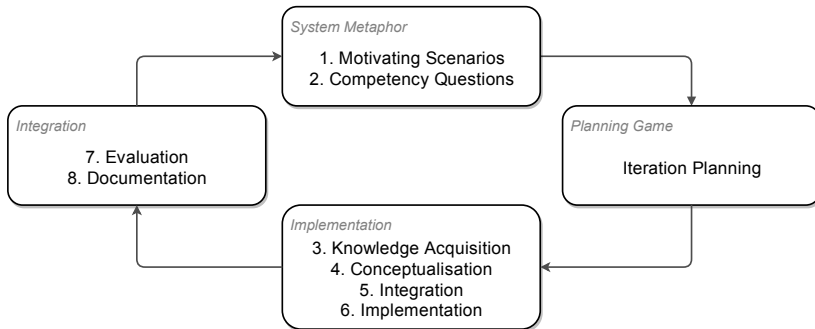
CKE AGILE PROCESS

Good practices

- Frist iteration: basic vocabulary as a reference point
- Subsequent iterations: from less to more formal

- Group:
    - the product owner, who has the whole system vision
    - the CKE process master, who oversees the project course
    - the team of 3-9 people: domain experts and 1-2 knowledge engineers

- Roles in the team:
    - the adders, who create a lot of material
    - the synthesizers, who take care about semantics and concepts interrelations
    - "the cops", who are responsible for imposing standards

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EUROPEAN WIKI

city:paris

Paris

Paris is the capital and most populous city of France, with an administrat
area of 105 square kilometres (41 square miles) and a 2015 population
2,229,621. The city is a commune and department, and the capital-heart
12,012-square-kilometre (4,638-square-mile) Ile-de-France region (colloc
known as the 'Paris Region'), whose 12,142,802 2016 population repres
roughly 18 percent of the population of France. By the 17th century, Pari
become one of Europe's major centres of finance, commerce, fashion, s
the arts, a position that it retains still today.

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Export to RDF

System Metaphor
1. Motivating Scenarios
2. Competency Questions

Planning Game
Iteration Planning

Implementation
3. Knowledge Acquisition
4. Conceptualisation
5. Integration
6. Implementation

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7. Evaluation
8. Documentation

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European Wiki

- ► Group of seven colleagues
- ► Description of all European countries
  $\rightarrow$ support during travels
- ► There is no "client" $\rightarrow$ one person
  selected as a product owner
- ► One selected as a CKE process master
- ► Basic knowledge of the KE $\rightarrow$ no
  knowledge engineer is needed

Here: the first iteration, three wiki pages,
two users (kkutt and yoda)

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EUROPEAN WIKI: STEP BY STEP

- ▸ Three use cases were proposed:
  - ▸ I want to see cities: A, B and C. In what order do I have to visit them to be able to use direct flights?
  - ▸ I want to see all European capitals. List all of them.
  - ▸ I am in city A. What is interesting here?
- ▸ Reasoning unit tests were specified

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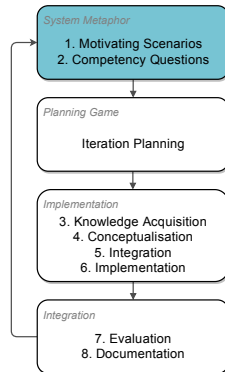
EUROPEAN WIKI: STEP BY STEP

In the first iteration three tasks were
defined:

- Describe London
- Describe Paris
- Describe Cracow

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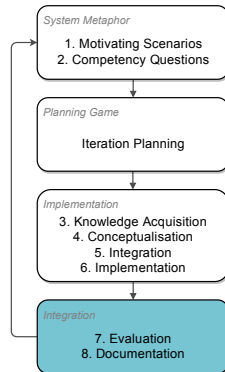000000000
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EUROPEAN WIKI: STEP BY STEP

- ▶ Two users, six changes
- ▶ Discussion of the diffcult points
- ▶ The semantic changelog created
- ▶ Gamification-based incentives for users
- ▶ Task management on an iteration board

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EUROPEAN WIKI: STEP BY STEP

▶ Reasoning unit tests: knowledge quality and the level of requirements fulfillment

▶ Comments with design decision made (`city` category)

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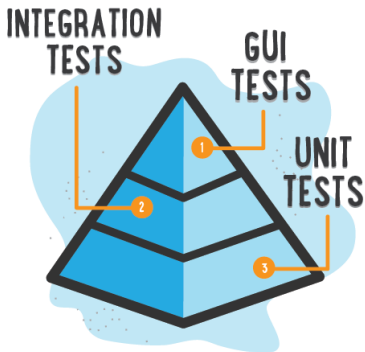
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QUALITY MANAGEMENT

Methods and Tools
Quality Management
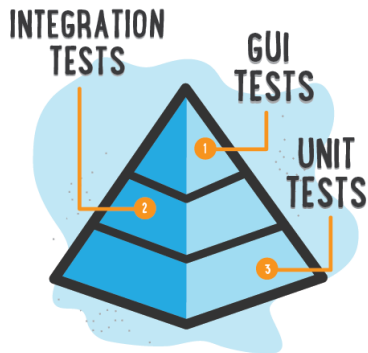Change Management
User Involvement

REASONING UNIT TESTS

IDEA ADOPTED FROM SOFTWARE ENGINEERING

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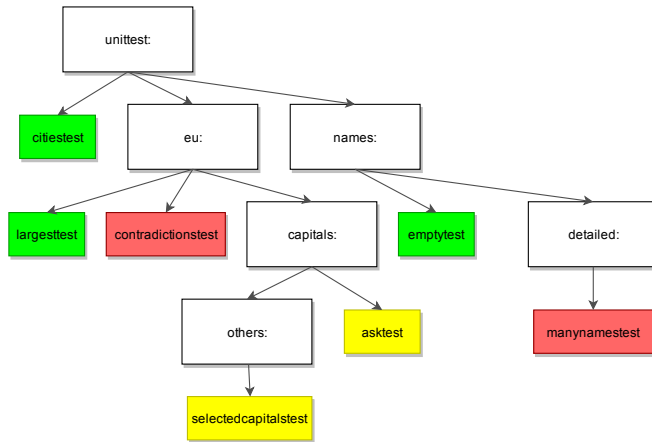SUMMARY
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REASONING UNIT TESTS

IDEA ADOPTED FROM SOFTWARE ENGINEERING

ILLUSTRATED BY SEGUE TECHNOLOGIES

Reasoning unit tests:

- ▶ Adopted by [164]
- ▶ Verify knowledge
- ▶ Define **expectations**

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REASONING UNIT TESTS

Tests hierarchy

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Reasoning Unit Tests

LOKI: 1. SPECIFY THE SPARQL-COMPATIBLE QUERY

```
1 <pl format="sparql">
2 PREFIX wiki: <>
3 SELECT ?page ?name
4 WHERE {
5   ?page a "city" .
6   ?page wiki:name ?name .
7   ?page wiki:largestSettlementOf wiki:organisation:eu .
8 }
9 </pl>
```

Reasoning Unit Tests

LOKI: 2. SPECIFY THE EXPECTED QUERY RESULT

```
1 <pl format="sparql">
2 PREFIX wiki: <>
3 SELECT ?page ?name
4 WHERE {
5    ?page a "city" .
6    ?page wiki: name ?name .
7    ?page wiki: largestSettlementOf wiki: organisation:eu .
8 }
9 </pl>
```

```
1 [[unittest_assert_anyequal:?name:Paris|Is Paris one of the
       largests?]]
2 [[unittest_assert_noneequal:?name:Cracow|Cracow is not one
       of the largests!]]
```

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Reasoning Unit Tests

Loki: 3. Check the results

Test results

Query result

page	name
london	Londinium
london	London
paris	Paris

Test: anyequal; Field name; Value: Paris Result: PASSED
Test: noneequal; Field name; Value: Cracow Result: PASSED

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REASONING UNIT TESTS

LOKI: 3. CHECK THE RESULTS

Test results

Query result

page	name
london	Londinium
london	London
paris	Paris

Test: anyequal; Field name; Value: Paris Result: PASSED
Test: noneequal; Field name; Value: Cracow Result: PASSED

Reasoning unit tests results:

Test	Status
citiestest	PASSED
eu:capitals:asktest	NOT EXECUTED
eu:capitals:others:selectedcapitalstest	NOT EXECUTED
eu:contradictionstest	FAILED
eu:largesttest	PASSED
names:detailed:manynamestest	FAILED
names:emptytest	PASSED

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REASONING UNIT TESTS

LOKI: 3. CHECK THE RESULTS

Reasoning unit tests results:

Test	Status
citiestest	PASSED
eu:capitals:asktest	NOT EXECUTED
eu:capitals:others:selectedcapitalstest	NOT EXECUTED
eu:contradictionstest	FAILED
eu:largesttest	PASSED
names:detailed:manynamestest	FAILED
names:emptytest	PASSED

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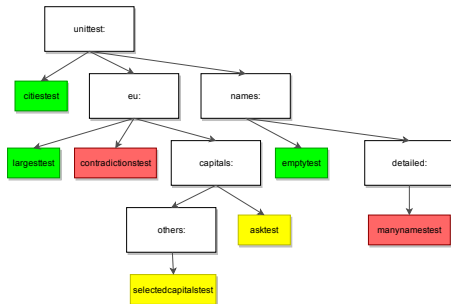
METRICS OF CHANGES

EXISTING ONTOLOGY METRICS

▶ **Attribute Richness:** an average number of attributes *att* per class *C*:

$$AR = \frac{|att|}{|C|} \tag{1}$$

▶ **Average Population:** the ratio of instances *I* to classes *C*:

$$AP = \frac{|I|}{|C|} \tag{2}$$

▶ **Size Of Vocabulary:** counts the vocabulary used in the ontology (instances *I* and attributes *att*):

$$SOV = |I| + |att| \tag{3}$$

▶ **Edge Node Ratio:** a ratio of all edges *E* (the number of all triples) to all nodes *N* (subjects and objects, both named and literals):

$$ENR = \frac{|E|}{|N|} \tag{4}$$

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METRICS OF CHANGES

CHANGE AND NORMALIZATION

Metric	1	2	3	4	5
AR	$(-\infty; -0.4)$	$[-0.4; -0.1)$	$[-0.1; 0.1]$	$(0.1; 0.4]$	$(0.4; \infty)$
AP	$(-\infty; -0.4)$	$[-0.4; -0.1)$	$[-0.1; 0.1]$	$(0.1; 0.4]$	$(0.4; \infty)$
SOV	$(-\infty; -4)$	$[-4; -1)$	$[-1; 1]$	$(1; 4]$	$(4; \infty)$
ENR	$(-\infty; -0.4)$	$[-0.4; -0.1)$	$[-0.1; 0.1]$	$(0.1; 0.4]$	$(0.4; \infty)$

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METRICS OF CHANGES

WEIGHTED AVERAGE

1. To promote **fast KB expansion**: based on *Size of Vocabulary*, which directly measures the database growth.

$$WA_1 = \frac{AR + AP + 5 \cdot SOV + ENR}{8} \tag{5}$$

2. To put emphasis on **KB coherence**: combine the values of *Attribute Richness*, *Average Population* and *Edge Node Ratio*. In this case classes with more attributes and instances are promoted, as they are indicators of richer KB.

$$WA_2 = \frac{5 \cdot AR + 5 \cdot AP + SOV + 3 \cdot ENR}{14} \tag{6}$$

METRICS OF CHANGES

THE 1st CHANGE IN THE EUROPEAN WIKI

```
1  ====== London ======
2
3  [[name:=London]] is the capital and most populous [[category:city|city]] of [[
       capitalOf::country:england|England]] and the [[capitalOf::country:uk|United
       Kingdom]].
4
5  Standing on the River Thames in the south east of the island of Great Britain,
       London has been a major settlement for two millennia. It was founded by the
       Romans, who named it [[name:=Londinium]].
6
7  London has a diverse range of people and cultures, and more than 300 languages
       are spoken in the region. Its estimated mid-2016 municipal population (
       corresponding to Greater London) was [[population:=8787892|8,787,892]], the
       largest of any city in the [[largestSettlementOf::organisation:eu|European
       Union]], and accounting for 13.4% of the UK population. London's urban
       area is the second most populous in the EU, after Paris, with 9,787,426
       inhabitants at the 2011 census. The city's metropolitan area is the most
       populous in the EU with 13,879,757 inhabitants, while the Greater London
       Authority states the population of the city-region (covering a large part
       of the south east) as 22.7 million. London was the world's most populous
       city from around 1831 to 1925.
```

- $AR = \frac{|att|}{|C|} = \frac{4}{1} = 4.00$

- $AP = \frac{|I|}{|C|} = \frac{1}{1} = 1.00$

- $SOV = |C| + |I| + |att| = 1 + 1 + 4 = 6$

- $ENR = \frac{|E|}{|N|} = \frac{7}{8} = 0.88$

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METRICS OF CHANGES

THE 1st CHANGE IN THE EUROPEAN WIKI

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1  ====== London ======
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      Authority states the population of the city-region (covering a large part
      of the south east) as 22.7 million. London was the world's most populous
      city from around 1831 to 1925.
```

▶ $AR = \frac{|att|}{|C|} = \frac{4}{1} = 4.00$

▶ $AP = \frac{|I|}{|C|} = \frac{1}{1} = 1.00$

▶ $SOV = |C| + |I| + |att| = 1 + 1 + 4 = 6$

▶ $ENR = \frac{|E|}{|N|} = \frac{7}{8} = 0.88$

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METRICS OF CHANGES

THE 1st CHANGE IN THE EUROPEAN WIKI

Metric	1	2	3	4	5
AR	$(-\infty; -0.4)$	$[-0.4; -0.1)$	$[-0.1; 0.1]$	$(0.1; 0.4)$	$(0.4; \infty)$
AP	$(-\infty; -0.4)$	$[-0.4; -0.1)$	$[-0.1; 0.1]$	$(0.1; 0.4)$	$(0.4; \infty)$
SOV	$(-\infty; -4)$	$[-4; -1)$	$[-1; 1]$	$(1; 4)$	$(4; \infty)$
ENR	$(-\infty; -0.4)$	$[-0.4; -0.1)$	$[-0.1; 0.1]$	$(0.1; 0.4)$	$(0.4; \infty)$

- $AR = \frac{|att|}{|C|} = \frac{4}{1} = 4.00$ (**5**)
- $AP = \frac{|I|}{|C|} = \frac{1}{1} = 1.00$ (**5**)

- $SOV = |C| + |I| + |att| = 1 + 1 + 4 = 6$ (**5**)
- $ENR = \frac{|E|}{|N|} = \frac{7}{8} = 0.88$ (**5**)

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OPINIONS AND DISCUSSION

No possibility to
automatically check all
quality aspects → user
evaluation is needed:

- Subjective
  assessment of
  changes (1-5 stars)

- A place for
  discussion and
  comments

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Opinions and discussion

No possibility to
automatically check all
quality aspects → user
evaluation is needed:

- Subjective
  assessment of
  changes (1-5 stars)

- A place for
  discussion and
  comments

Change management

Methods and Tools
  Quality Management
  Change Management
  User Involvement

Change ontologies

- Cover two aspects of change:
  - **the factual change** (<u>What</u> was done? e.g. Typos or other small bugs fixed, New content added)
  - **the goal** (<u>Why</u> it was done? e.g. Errors fixing, Knowledge database expansion)
- Created for specific purposes, e.g. for preparing conference papers

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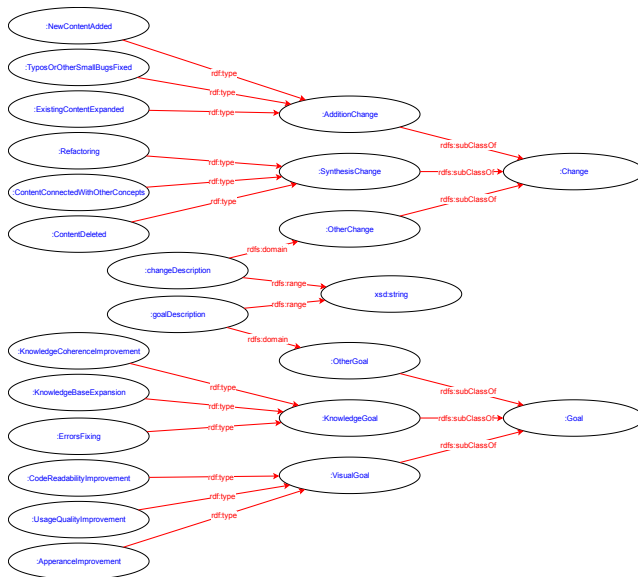
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CHANGE ONTOLOGIES

EXTENDED WIKI EDITION FORM

INTRODUCTION   CKE PROCESS   **METHODS AND TOOLS**   EVALUATION   SUMMARY

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SEMANTIC CHANGELOG

- Graph-based changelog (RDF grounded)
- Describes the relations between Agents (users), Activities (created, edit, delete) and Entities (wiki pages, revisions of pages)
- Collects all available information: metadata, tests results, metrics, opinions, change ontologies, …

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SEMANTIC CHANGELOG

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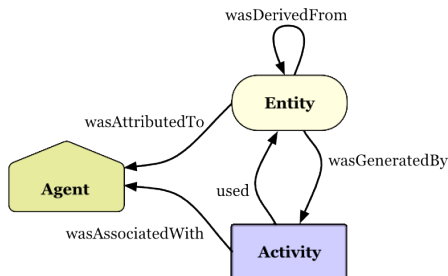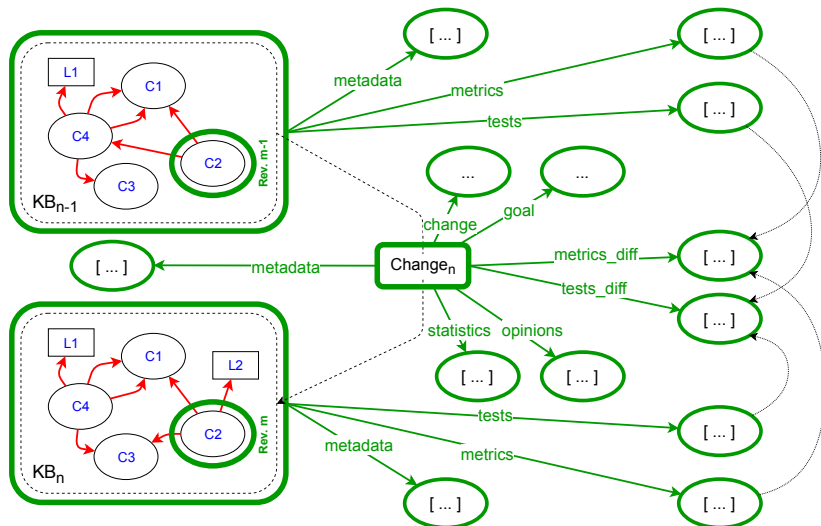
Semantic changelog
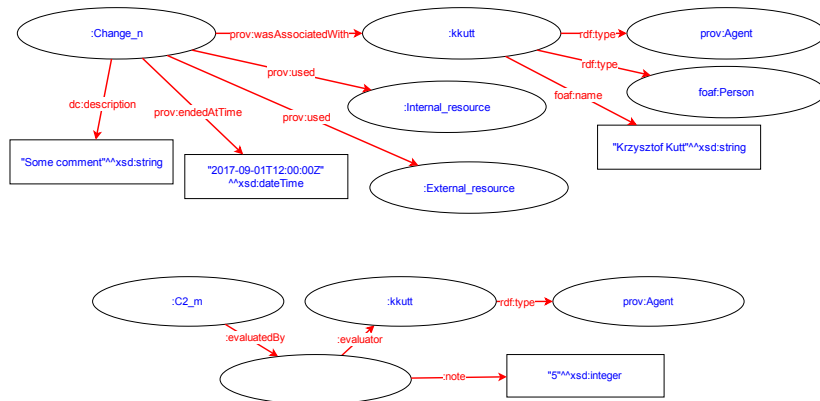
Semantic changelog

IDENTIFICATION OF USERS ASSOCIATED WITH LOW QUALITY CHANGES

```sparql
 1 SELECT ?user (COUNT(?user) as ?maliciousChanges)
 2 WHERE {
 3     ?change a prov:Activity ;
 4         loki:testsPassed [ loki:valueBefore ?testsBefore ;
 5                            loki:valueAfter ?testsAfter ] ;
 6         loki:weightedAverage ?metric ;
 7         prov:wasAssociatedWith ?user .
 8     FILTER (?testsBefore > ?testsAfter) .
 9     FILTER (?metric < 3.0) .
10 }
11 GROUP BY ?user
12 ORDER BY DESC(?maliciousChanges)
13 LIMIT 5
```

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SEMANTIC CHANGELOG

USERS' TYPES IDENTIFICATION

```
 1  SELECT ?user ?type
 2  WHERE {
 3      {
 4          SELECT ?user (COUNT(?user) AS ?additions)
 5          WHERE {
 6              ?change rdf:type prov:Activity ;
 7                  loki:whatWasDone ?changeType ;
 8                  prov:wasAssociatedWith ?user .
 9              ?changeType rdf:type change:AdditionChange .
10          }
11          GROUP BY ?user
12      }
13      UNION
14      {
15          SELECT ?user (COUNT(?user) AS ?syntheses)
16          WHERE {
17              ?change rdf:type prov:Activity ;
18                  loki:whatWasDone ?changeType ;
19                  prov:wasAssociatedWith ?user .
20              ?changeType rdf:type change:SynthesisChange .
21          }
22          GROUP BY ?user
23      }
24      BIND(if(( ?additions > ?syntheses ), "Adder", "Synthesizer") AS ?type)
25  }
```

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USER INVOLVEMENT

Methods and Tools
Quality Management
Change Management
User Involvement

Gamification

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GAMIFICATION

Adders vs. Synthesizers?

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GAMIFICATION

The simple *points* (pts) system:
- ▶ Login to the system – 5 pts once a day,
- ▶ New concept added – 25 pts,
- ▶ Concept edition – 5 pts.

Points and *badges* as a result of achievements:
- ▶ For logging in for *X* days in a row:

X	Points	Badge
1	10	Welcome to the *Y*
2	15	*Y* is Fun
3	15	*Y* is Really Fun
7	25	*Y* for a Whole Week
14	40	Two Weeks in a Row?
30	40	You Have to be Addicted

- ▶ For creating *X* new concepts ...
- ▶ For *X* editions ...

Levels calculated according to the equation (value is rounded to the tens):

$$P_{L+1} = 40L^{\frac{5}{3}} + 10 \tag{7}$$

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GAMIFICATION

Adders vs. **Synthesizers?**

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Gamification

- *Bounty* system – challenges ("parse the source Y into the KB") and rewards
- *Natural tests* mechanism – random changes and concepts: mark them as good or bad
- *User's credibility* – average of:
  - ratio of reasoning unit tests passed to all tests
  - weightedAverage metric
  - mean value of votes given
  - ratio of positive natural tests values to all ratings given

  Threshold of 70% → the "Trusted user" badge

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GAMIFICATION

EUROPEAN WIKI

Change	User	Achievements
Ch_1	kkutt	Login to a system: 5 pts; New concept added: 25 pts; Logging in for 1 day: 10 pts + Badge "Welcome to the European Wiki"; Creation of 1 concept: 10 pts + Badge "My First Concept"
Ch_2	yoda	Login to a system: 5 pts; New concept added: 25 pts; Logging in for 1 day: 10 pts + Badge "Welcome to the European Wiki"; Creation of 1 concept: 10 pts + Badge "My First Concept"
Ch_3	kkutt	New concept added: 25 pts
Ch_4	yoda	Concept edition: 5 pts; Edition of 1 concept: 10 pts + Badge "Going Down in History"
Ch_5	yoda	Concept edition: 5 pts
Ch_6	kkutt	Concept edition: 5 pts; Edition of 1 concept: 10 pts + Badge "Going Down in History"

GAMIFICATION

European Wiki

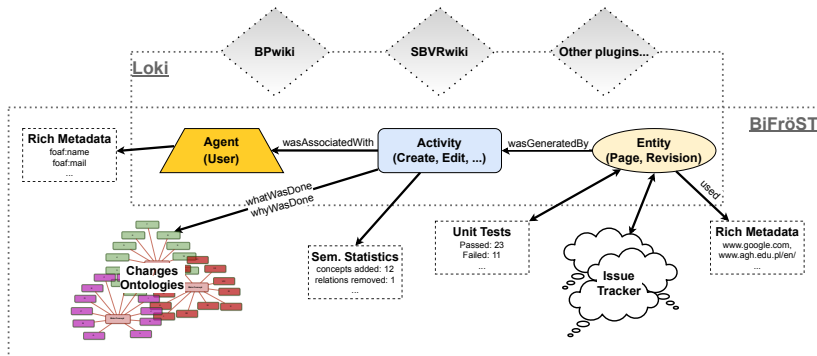| User	Ratio of unit tests passed	Weighted average metric	Votes	Final Credibility
`kkutt`	$\frac{2.33}{6}$ (**44%**)	3.71 (**74%**)	N/A	**59%**
`yoda`	$\frac{3}{6}$ (**50%**)	3.91 (**78%**)	4 (**80%**)	**70%**

TOP 10

1. kkutt(2) 90 pts
2. yoda(2) ✓ 70 pts

city:paris

Paris

Paris is the capital and most populous city of France, with an administrative-limits area of 105 square kilometres (41 square miles) and a 2015 population of 2,229,621. The city is a commune and department, and the capital-heart of the 12,012-square-kilometre (4,638-square-mile) Ile-de-

BiFröST Framework för Semantical Tracking

USABILITY

ONTOLOGY STORAGE + CODE HINT AND COMPLETION


```
[[category:
```

```
[[category:actor]]
[[category:actress]]
```

"Cops" are no longer
needed!

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5 EXPERIMENTS

Module (plugin) / Feature	Experiment				
	1st	**2nd**	**3rd**	**4th**	**Final**
Loki	+	+	+	+	+
Reasoning unit tests (Loki)					+
Metric of changes (prov)				+	+
Opinions and discussion (revisionsrater)					+
Change ontologies (prov)		+	+	+	+
Semantic changelog (prov)		+	+	+	+
Gamification (wikigame)					+
Usability extensions (Loki)			+		+
CKE agile process	+	+	+	+	+
Usability evaluation (SUMI)					+
Comparison with SMW				+	

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4 SUPPORTING EXPERIMENTS

1ST. POKEMONS, SIMPSONS, ET AL.

	Phase 1: Creation	Phase 2: Annotation	Phase 3: Evaluation
Team 1	Pokemons	Simpsons	Dragon Ball Z
Team 2	Drinks	Dragon Ball Z	Simpsons
Team 3	Simpsons	Pokemons	Drinks
Team 4	Dragon Ball Z	Drinks	Pokemons

- ▶ 6 weeks
- ▶ 8 students
- ▶ 3000 changes
- ▶ 1891 triples
- ▶ 345 wiki pages

The most important conclusions:

- ▶ experts and engineers **must** collaborate at every stage
- ▶ need for more strictly controlled conditions

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4 SUPPORTING EXPERIMENTS

2ND: CSP LIBRARY

The most important conclusions:

- ► simple iterative process:
    1. competency questions
    2. implementation
    3. evaluation
- ► 5 iterations
- ► 13 students
- ► 1186 changes
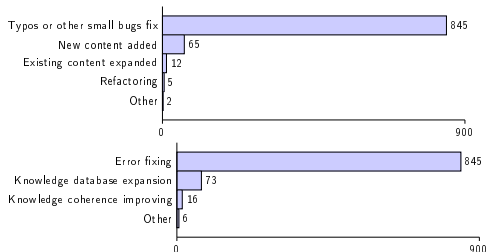- ► 821 triples
- ► 265 wiki pages

- ► important steps and roles in process identified
- ► reasoning unit tests idea proposed

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4 SUPPORTING EXPERIMENTS

3RD: PUBS IN CRACOW

The most important conclusions:

- ▶ updated change ontology seems to be good enough
- ▶ a need for task board identified
- ▶ new version of plugin forced users think about change type and goal:

- ▶ updated iterative process
- ▶ 5 iterations
- ▶ 15 students
- ▶ 665 changes
- ▶ 1031 triples
- ▶ 202 wiki pages

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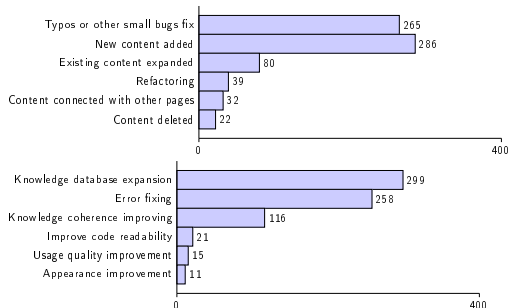
4 SUPPORTING EXPERIMENTS

4TH: ARTIFICIAL INTELLIGENCE CLASS

	Changes	Wiki pages	Triples
Wiki A (Loki)	2417	177	1113
Wiki B (SMW)	2629	108	1422

The most important conclusions:

- ▶ 1 hour introductory training is not enough?

- ▶ Semantic MediaWiki vs Loki

- ▶ 56 (A) + 49 (B) students

- ▶ group of 50 people is too big for self-management

- ▶ a strong leader or subgroup who would make any decision had not emerged

- ▶ motivation: focused on educational process itself

- ▶ no significant differences between reported difficulty for SMW and Loki

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FINAL EXPERIMENT

Cookbook and Movies KB

- ▶ 16 students (Cookbook), 5 iterations
- ▶ 5 knowledge engineers (online call, Movies KB)

The most important conclusions:

- ▶ even simple iteration board is a great idea
- ▶ there were no "cops" (thanks to the hint and completion mechanism)
- ▶ conflicts still appeared ("egg" vs "eggs"?) – resolved via discussion

Final evaluation

- Observation and user questionnaires: process was clear and robust
- Each module works good enough
- All modules of BiFröST framework smoothly interact with each other
- Users generally felt satisfied (SUMI inventory)

SUMI Scale Profiles: Means with Standard Deviations
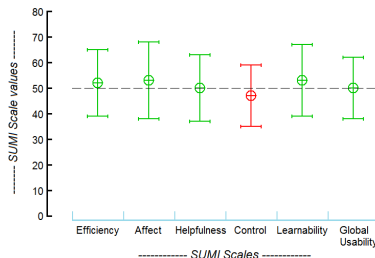
Semantic Wiki	Requirements (max 26)
SMW	17
KnowWE	17
OntoWiki	14
Loki (before PhD)	14
Loki (with BiFröST)	**23**

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OBJECTIVES

*The main goals were to **describe a Collaborative Knowledge Engineering process** that provides a general framework for defining roles which should be identified in a group and steps that should be taken in this process, as well as to propose **methods and tools that support the defined CKE process**, leading to the creation of good quality KB in reasonable time, through the means that will be convenient for target users.*

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The most important results:

► Analysis of **issues and challenges** for CKE

► Definition of **CKE agile process**

► Conceptualization of **change ontology**

► Proposal of **graph-based semantic changelog**

► Formulation of **involvement metrics**

► Implementation of **prototypical toolkit** (BiFröST)

Future works:

► (semi-)automation: machine learning model that supports selection of change ontology concepts

► sources credibility and other usage scenarios for semantic changelog

► application of presented CKE process in digital humanities and software engineering

SUMMARY

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- ▶ Analysis of **issues and challenges** for CKE
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- ▶ (semi-)automation: machine learning model that supports selection of change ontology concepts
- ▶ sources credibility and other usage scenarios for semantic changelog
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