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A Learning Content Authoring Approach based on Semantic Technologies and Social Networking: an Empirical Study

吴鹏飞

2014年10月27日

摘要分析

人工智能与信息计算科学系

A Learning Content Authoring Approach based on Semantic Technologies and Social Networking: an Empirical Study

Saša Nešić[1], Dragan Gašević [2], Mehdi Jazayeri[3] and Monica Landoni[3]

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ABSTRACT

Semantic web technologies have been applied to many aspects of learning content authoring including semantic annotation, semantic search, dynamic assembly, and personalization of learning content. At the same time, social networking services have started to play an important role in the authoring process by supporting authors' collaborative activities. Whether semantic web technologies and social networking improved the authoring process and to what extent they make authors' life easier, however, remains an open question that we try to address in this paper. We report on the results of an empirical study based on the experiments that we conducted with the prototype of a novel document architecture called SDArch. Semantic web technologies and social networking are two pillars of SDArch, thus potential benefits of SDArch naturally extend to them. Results of the study show that the utilization of SDArch in authoring improves user' performances compared to the authoring with conventional tools. In addition, the users' satisfaction collected from their subjective feedback was also highly positive.

Keywords

Empirical study, Learning content authoring, Semantic web technologies, Social networking

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实证研究；学习内容创作；语义网；社会网络

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摘要分析

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语义网技术已经应用在学习内容创作的许多方面，包括语义标注、语义搜索、动态聚合及学习内容个性化。同时，社会网络服务通过对创作者协作行为支持在创作过程中也扮演着重要角色。（呼应标题）

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语义网技术和社会网络是否能够带来创作过程的提升？在何种程度上使得创作者更简单化？（提出问题）

ABSTRACT

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摘要分析

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基于实验做了实证研究，实验是基于新的文档框架原型–SDArch。
SDArch 两大支柱是语义网技术和社会网络。
实验结果显示，在创作中SDArch的应用能提升用户表现（利用传统工具比较）和用户满意度（文章从做了什么工作、采用了何种方法、结果如何方面支持对上述2个问题的回应）

ABSTRACT

Semantic wel
annotation, s
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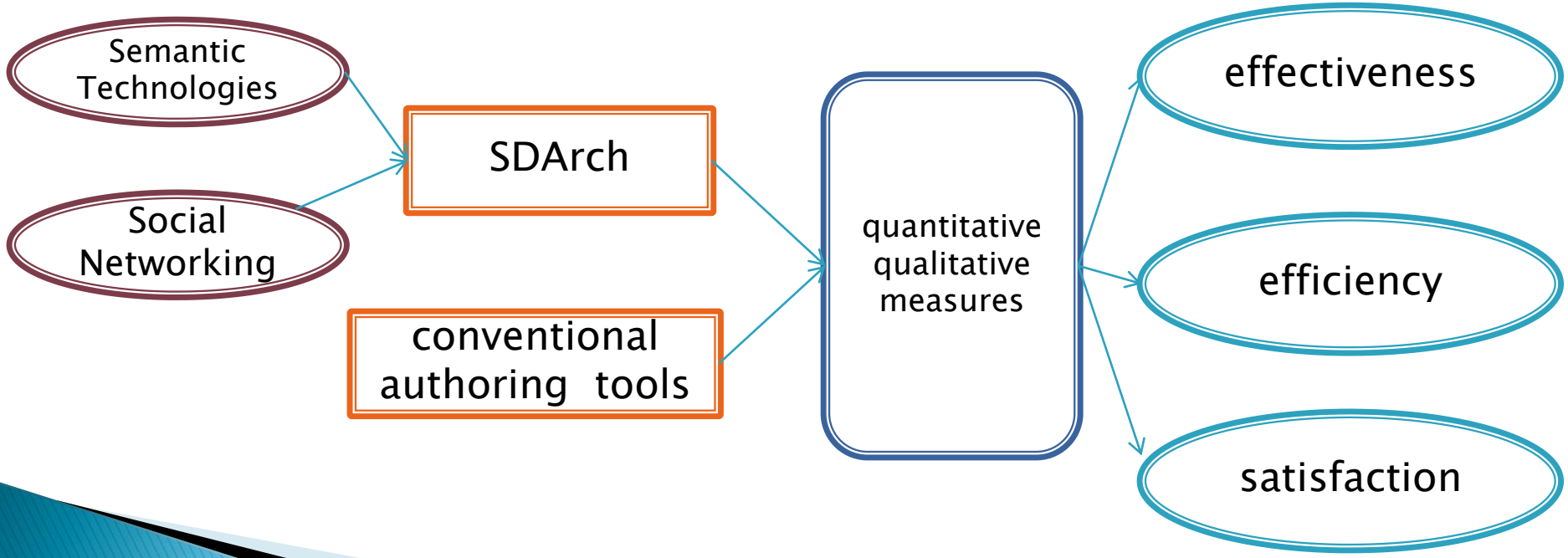
内容组织体系分析-Introduction

- 学习内容从零创作是一项困难和费事费力的工作。很多创作者是通过重用和修改已有的学习内容进行创作而不是从零开始(Betty & Allard, 2004)。学习内容一方面是教学和学习，另一方面就是共享和重用。需要提供一种有意义的资源获取方式来重用学习内容。
- 很多研究者针对重用问题利用语义网技术实现学习内容的标准化和语义标注(Duval et al., 2001; Jovanović et al., 2006)。利用语义标注的研究显示该方法能够提升学习内容创作的现状问题，但是同时也存在着问题：
- （1）相对于传统的元数据标注，基于本体的语义标注是前进了一步，然而当学习内容通过语义标注之后能实现学习内容有效检索，那么语义检索的潜力也就用完成了。因此，不仅需要语义标注，而且也需要学习内容之间的关联框架及逻辑断言。
- （2）目前的学习内容分散、孤岛、访问受限与Web2.0背道而驰((Berners-Lee et al., 2006).
- （3）资源库虽然提供基于LO标准的联邦检索协议进行大文档检索，但是用户更倾向于重用原始的学习内容文档（PDF、Word）一部分内容(Jovanović et al., 2006).。
- （4）虽然传统的创作工具支持协作活动，但是应用多是面向个人、社会化活动关注较少。在内容创作中，学习内容创作者之间的社会化关系及其资源的利用方式是有用的信息。

内容组织体系分析-Introduction

- 语义文档框架-SDArch（作者开发的原型）来解决上述问题。
- 目前，语义网技术应用与学习内容创作已有研究(Duval et al., 2001; Dodero et al., 2005; Jovanović et al., 2006; Henze, 2005), 但是上述研究没有提供实验数据来验证， 在effectiveness, efficiency and satisfaction程度方面还无法说明。



内容组织体系分析-Related Work

- 语义网技术应用在learning content authoring：语义标注为实现发现和重用(Duval et al., 2001)，利用本体和语义协议实现学习内容的协同创建(Dodero et al., 2005)，利用语义网技术实现学习内容的动态聚合和个性化(Jovanović et al., 2006; Henze, 2005)。
- 社会网络应用在E-learning中：educational social software(Anderson, 2005)，社会网络工具支持E-learning中的社会性建构(Friensen et al., 2004)，支持自我控制(Klamma et al., 2006)、基于问题的和协作行为(Gillet et al., 2008)，与LMS整合(Gillet et al., 2005)。
- 提出从实证的角度还缺乏相关研究。

内容组织体系分析-Authoring of Course Material – Motivational Scenario

- 课程内容创作-动机场景描述（讲故事方式描述）
- Mark的课件在一系列工具支持下提供4种新的服务

Let us suppose that Mark is a university professor who teaches 'Software Architecture and Design' course. For each topic in the course Mark usually prepares presentation slides that he uses during his class. The next topic to be presented in the course is 'Software Design Patterns'. Mark has the presentation on this topic from previous year, but he does not want to reuse it as it is. In order to prepare as good presentation as possible, with up to date information, Mark plans to consider the existing presentation, then presentations on the same topic used by his colleagues at other universities, and some other articles related to the topic from his archive as well as those of his colleagues. As usual, Mark is going to use PowerPoint to prepare the presentation, as he is most confident and familiar with it. However, this time his PowerPoint is extended with a set of tools that provide him a range of new, novel services, which we could categorize into four groups.

内容组织体系分析-Authoring of Course Material – Motivational Scenario

- 社会网络服务：支持相同教学内容人组建社会网络。
- 课件文档转换服务：支持课件文档内容单元的语义标注、标识和重用。
- 语义检索服务：支持课件文档内容单元的语义检索，并跟踪记录内容单元交互数据。
- 浏览服务：支持语义链接关联内容单元。

- to form a social network around a given topic of interest;
- to transform their local documents in a new form that will enable semantic integration (i.e., semantic annotation and linking) of related data kept in different documents;
- to share such transformed documents within the social network, and thus, semantically integrate related document data that originate from different users;
- to semantically search local and shared collections of the semantically integrated documents for desired data; and
- to navigate across local and shared document collections by following semantic links between document units and thus discover more data units of their interest.

内容组织体系分析-Semantic Documents

Semantic Document:

特征（unique identification, semantic annotation, and semantic linking）

整合（ the desktop information space and the information space of the online social network communities）

① Semantic Document Model – SDM

② Semantic Document Architecture – SDArch

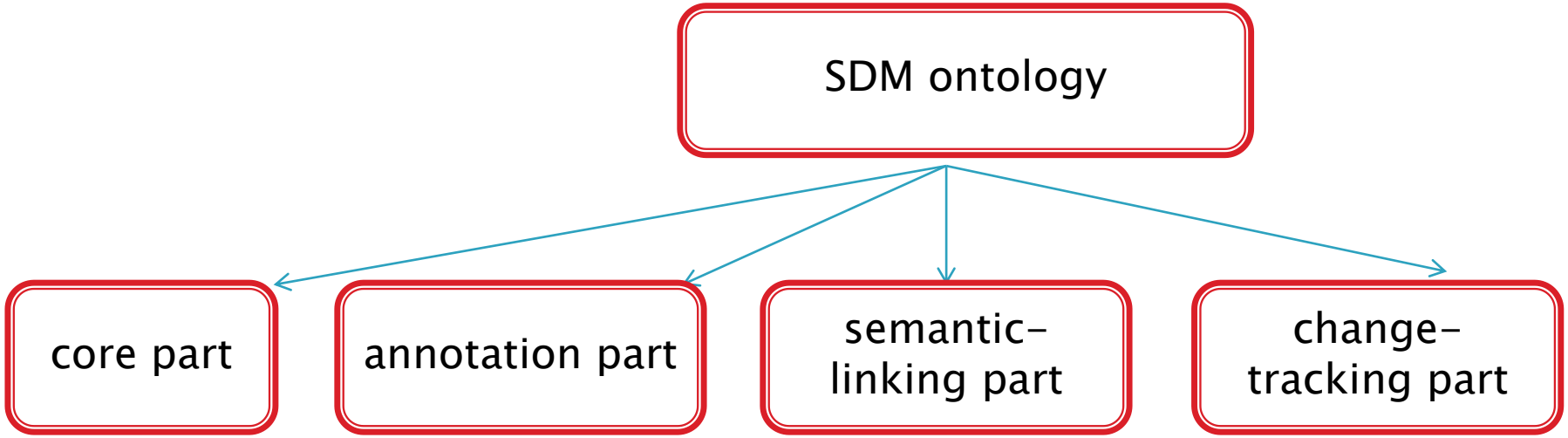
③ SemanticDoc Tools

内容组织体系分析-SDM

- Semantic Document Model – SDM

SDM defines semantic documents as composite information resources composed of uniquely identified, semantically annotated, and semantically interlinked document units (DUs) of different granularity (Nešić, 2009). Each semantic

- SDM ontology-formal specification of SDM



内容组织体系分析-SDM ontology

A. The core part of the SDM ontology:定义内容单元类型及其结构化关系类和属性。
B. The annotation part of the SDM ontology：定义描述标注的词汇，如描述DU 标注类型semantic annotation, social-context annotation and pedagogical annotation. 如描述教学角色 (e.g., abstract,introduction, conclusion, definition, explanation, description, illustration, example and exercise) 。
C. The semantic-linking part of the SDM ontology：定义内容单元语义链概念。
D. The change-tracking part of the SDM ontology：定义内容单元可能的变化词汇。

内容组织体系分析-SDArch

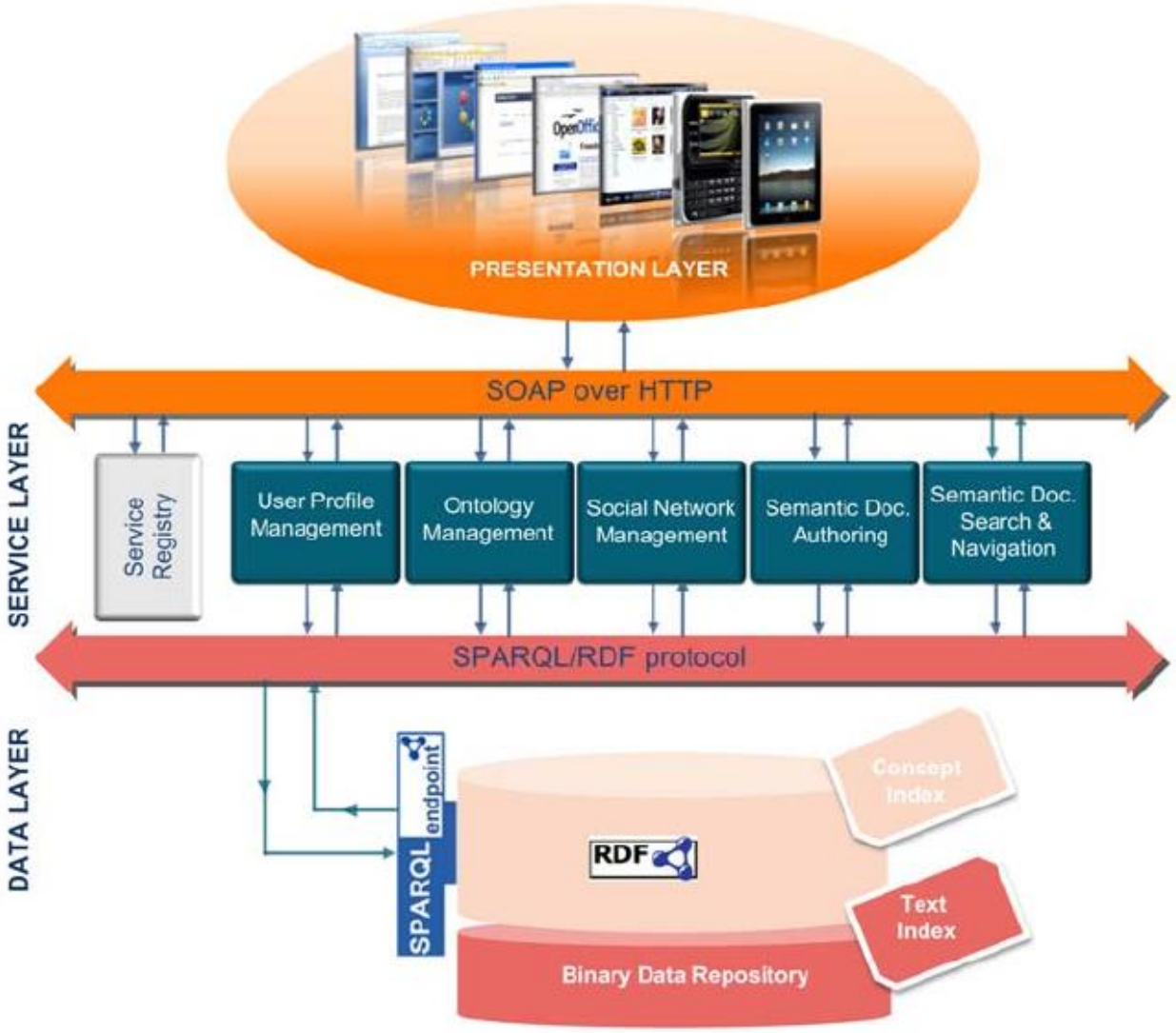


Figure 1. Illustration of the SDArch architecture

语义文档框架

内容组织体系分析-SemanticDoc Tools

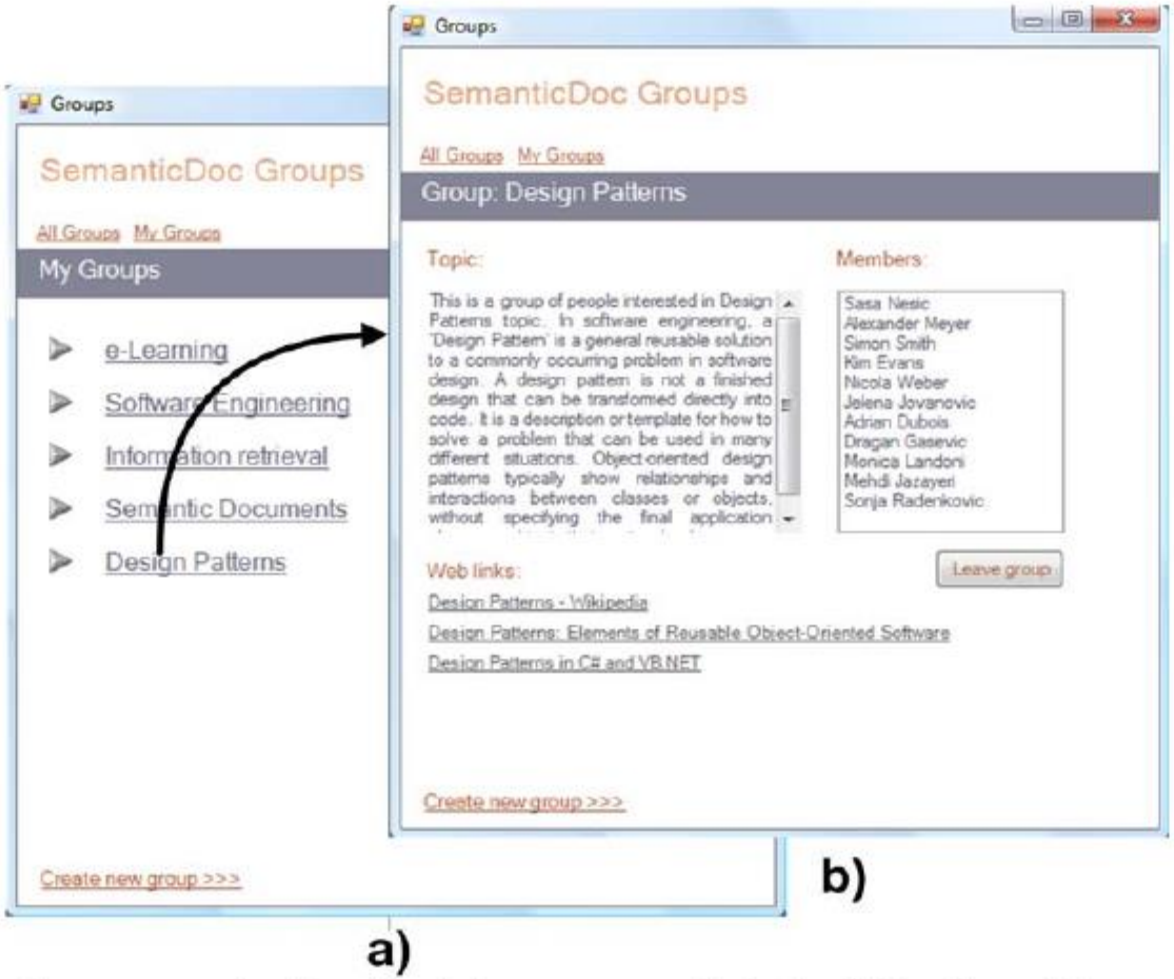
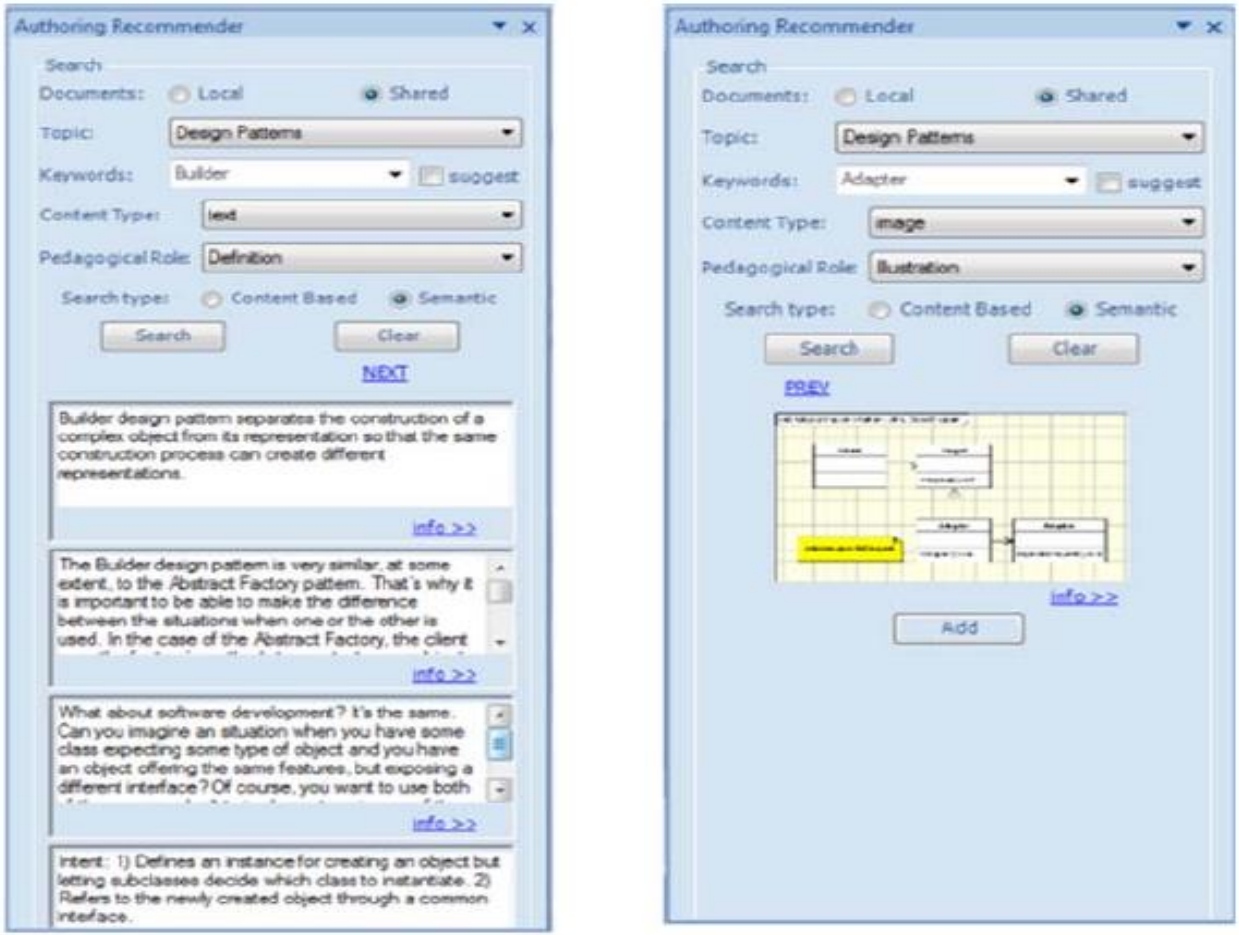


Figure 2. Social network manager: a) a list of existing groups within the SDArch social network, b) a detailed view of a selected group

1 提供社会网络管理界面

内容组织体系分析-SemanticDoc Tools



a) b)

提供个性化语义文档搜索界面

Figure 3. Document Recommender: a) an example search for textual document units, and b) an example search document units of the image content type

内容组织体系分析-SemanticDoc Tools

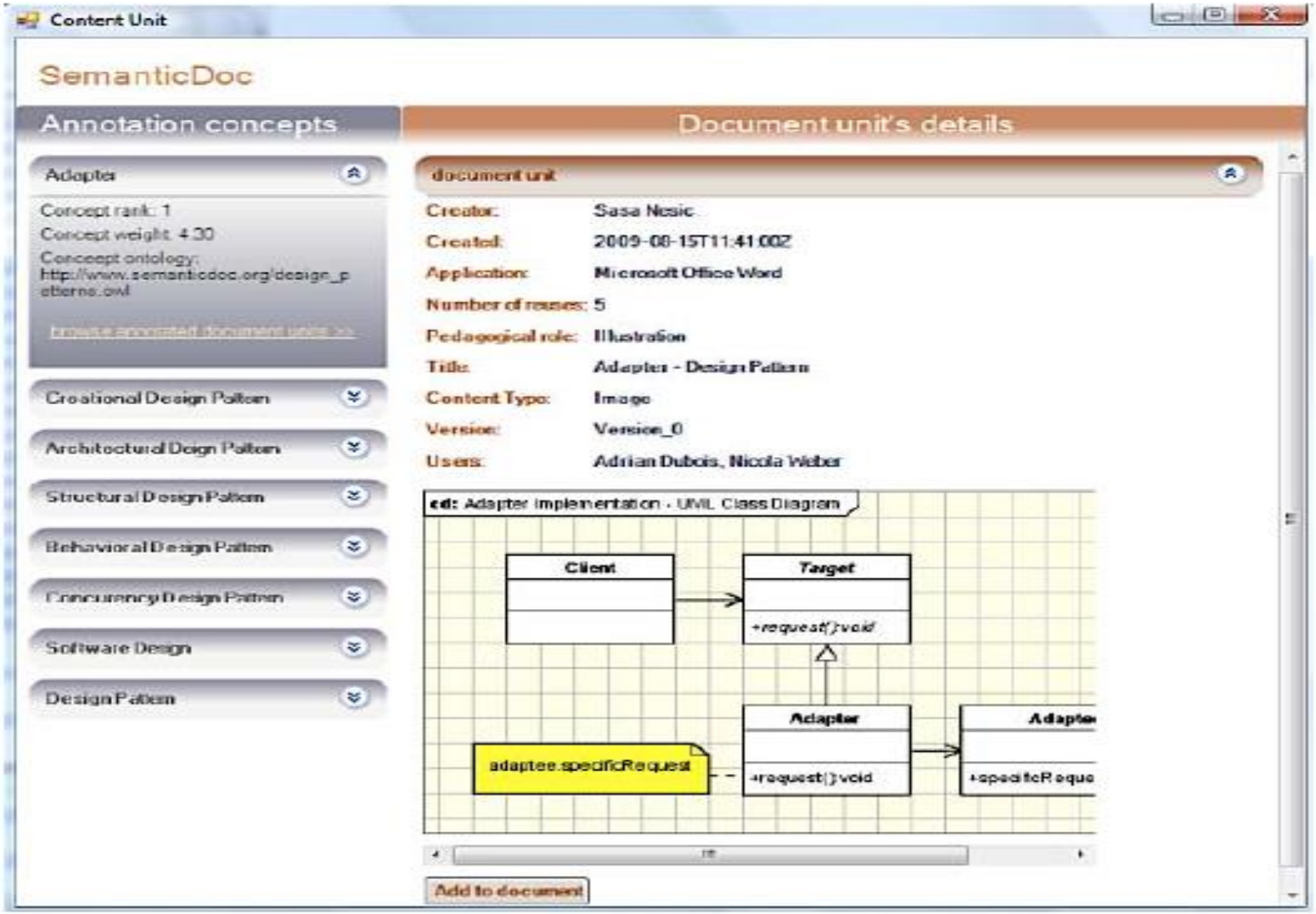
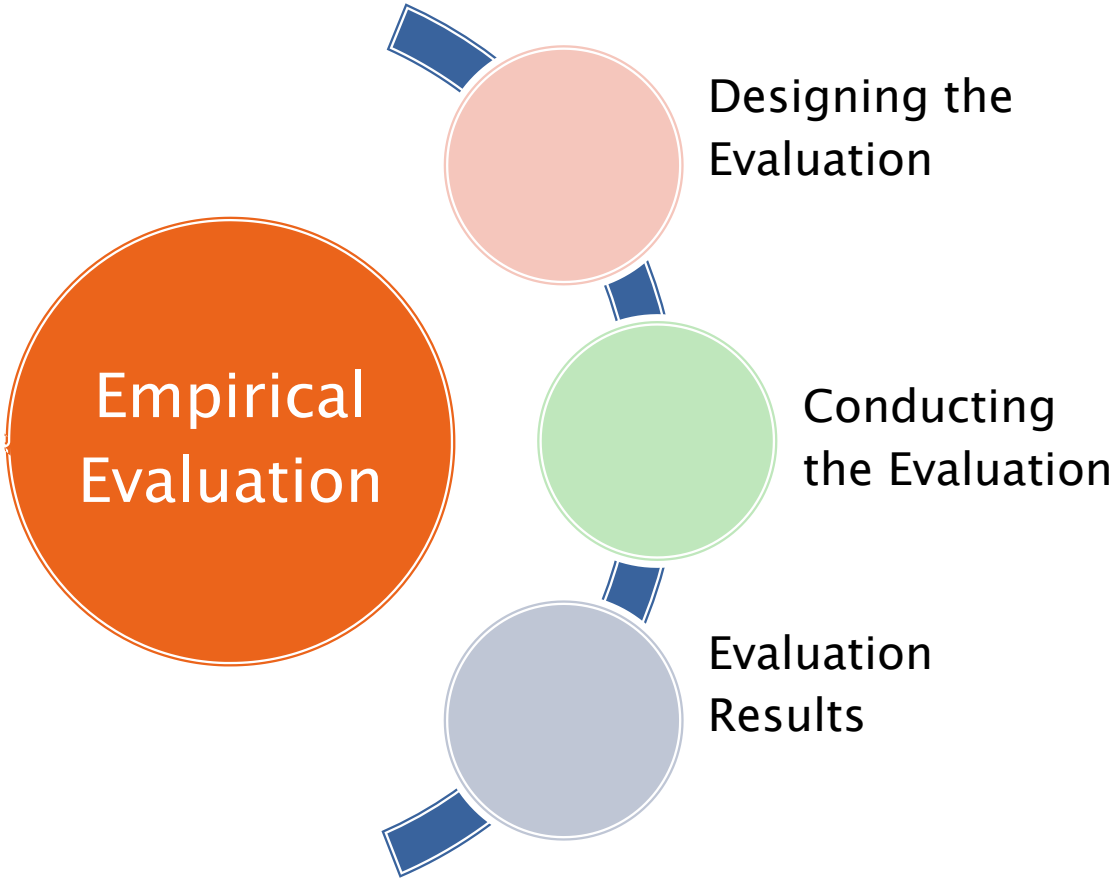


Figure 4. Semantic document browser

1 提供语义文档浏览界面

内容组织体系分析- Empirical Evaluation of the Proposed Authoring Scenario



Designing the Evaluation

- 制定了评估的假设(3个方面）如下：

"Using semantic web technologies and social networking results in a more **effective**, **efficient**, and **satisfactory** experience, when authoring course material compared to the conventional authoring approach."

- With respect to user **effectiveness**, we intended to measure the accuracy and completeness with which SDArch users complete authoring tasks. In other words, how many and what tasks the users can complete successfully using the SDArch services and tools.
- With respect to user **efficiency**, we intended to measure the resources expended in relation to the accuracy and completeness with which SDArch users complete the authoring tasks. In other words, how much effort the users spend for completing these tasks using the SDArch services and tools.
- With respect to user **satisfaction**, we intended to measure the freedom from discomfort, and positive attitudes towards the use of the SDArch services and tools in authoring of course material.

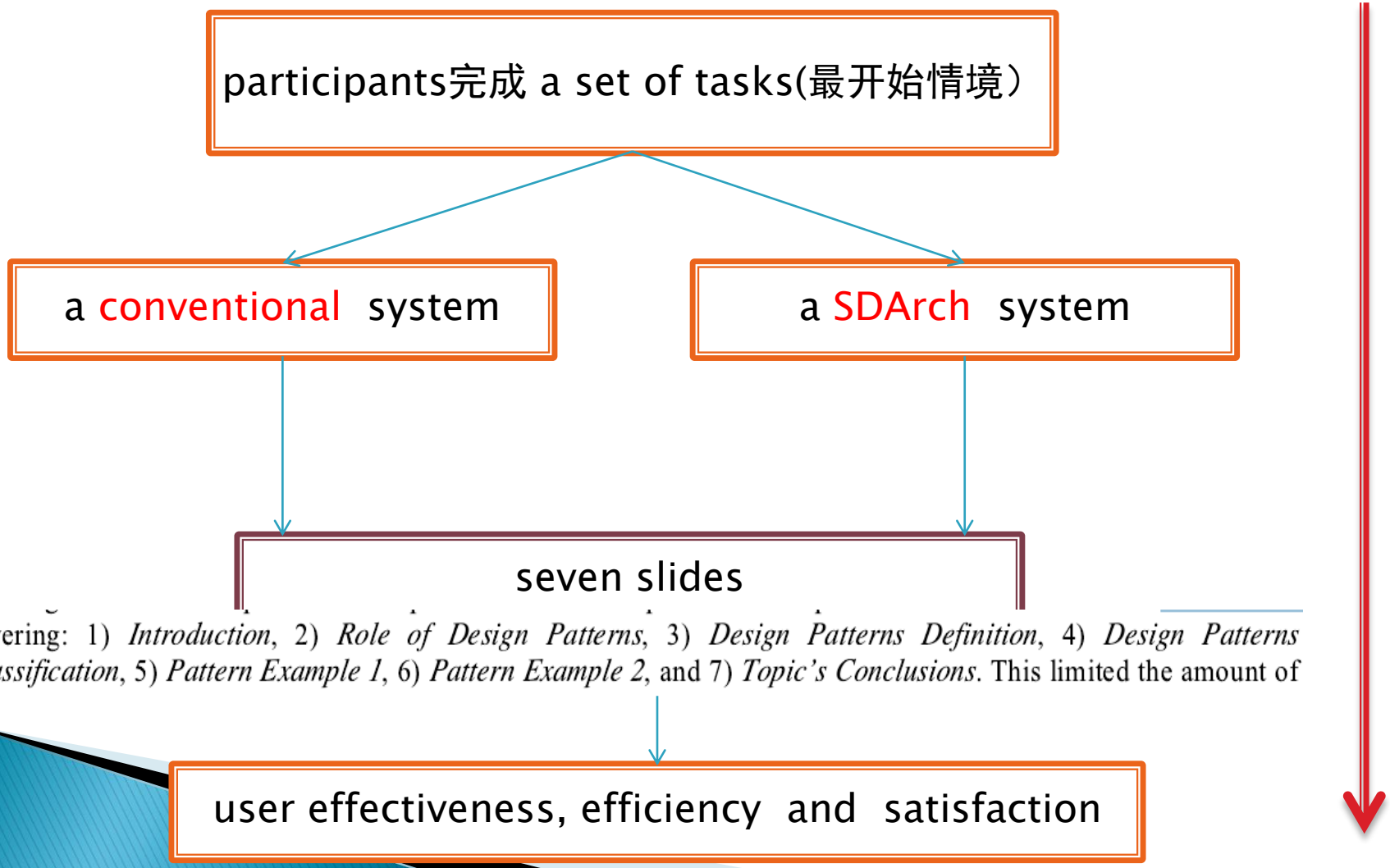
Designing the Evaluation

task-based comparative evaluation (Whittaker et al., 2000)
goal-question-metrics (GQM) measurement model (Bastili et al., 1994)
subset of questions/statements from the Perceived Usefulness and Ease of Use questionnaire (Davis, 1989)

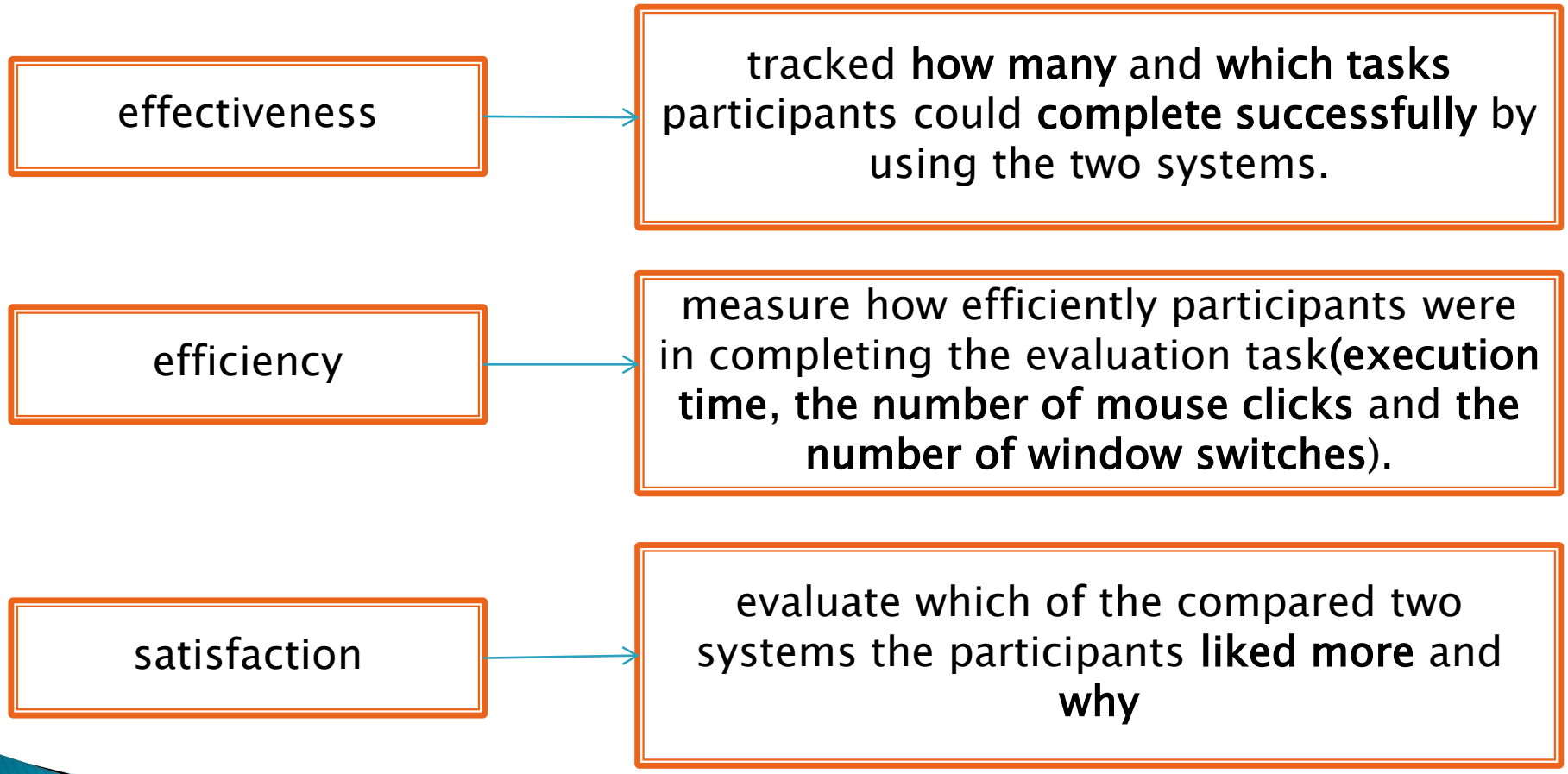
a conventional Windows system equipped by regular MS Office

a Windows system featured by SDArch services and MS Office extended by the SemanticDoc tools

Designing the Evaluation



Designing the Evaluation



Designing the Evaluation

- 评价标准及方法矩阵

Table 1. Evaluation criteria and the corresponding evaluation methods and metrics

Evaluation Criterion	Evaluation Method	Evaluation Metric
Effectiveness	Objective – Quantitative Measure	Task Success Rates
Efficiency	Objective – Quantitative Measure “ “	Task Completion Times Number of Mouse Clicks Number of Window Switches
Satisfaction		5-level Likert scale

Designing the Evaluation

- 实证研究中的被试选择(5个专家用户—6个参与者）

The initial step of an empirical evaluation is the selection and recruitment of participants, whose background and abilities are representative of intended users of the system to be evaluated (Nielsen, 1993). The evaluation results will only be valid if the participants are typical users of the system, or as close to that criterion as possible. Another issue regarding the selection of the participants, which has attracted a lot of attention in the HCI community, is what should be a sufficient number of participants of the usability study. In terms of quality, Nielsen (Nielsen et al., 2003) argues that five expert users are sufficient to discover 85% of the usability problems in a system under evaluation. In our evaluation, we had six participants from three universities: University of Lugano (www.usi.ch), Switzerland; Simon Fraser University (www.sfu.ca), Canada; and University of Belgrade (www.bg.ac.rs), Serbia. All the participants were volunteers and had genuine motivation in using the new systems. Moreover, each participant had been involved in some courses covering the topic of our evaluation scenario, either as a lecturer or teaching assistant. Thus, they qualified as domain experts and final users of the system.

Conducting the Evaluation

the preparation phase
(to create SDArch social network, to collect the evaluation document set, and to familiarize the participants with the SDArch services and tools)

1. initiated the SDArch social network by using the social network manager tool and created a software design patterns interest group.

2. transformed initial 20 documents from archive into semantic documents and added them to the group's shared sds repository

3. participants register to SDArch social network and to join the group

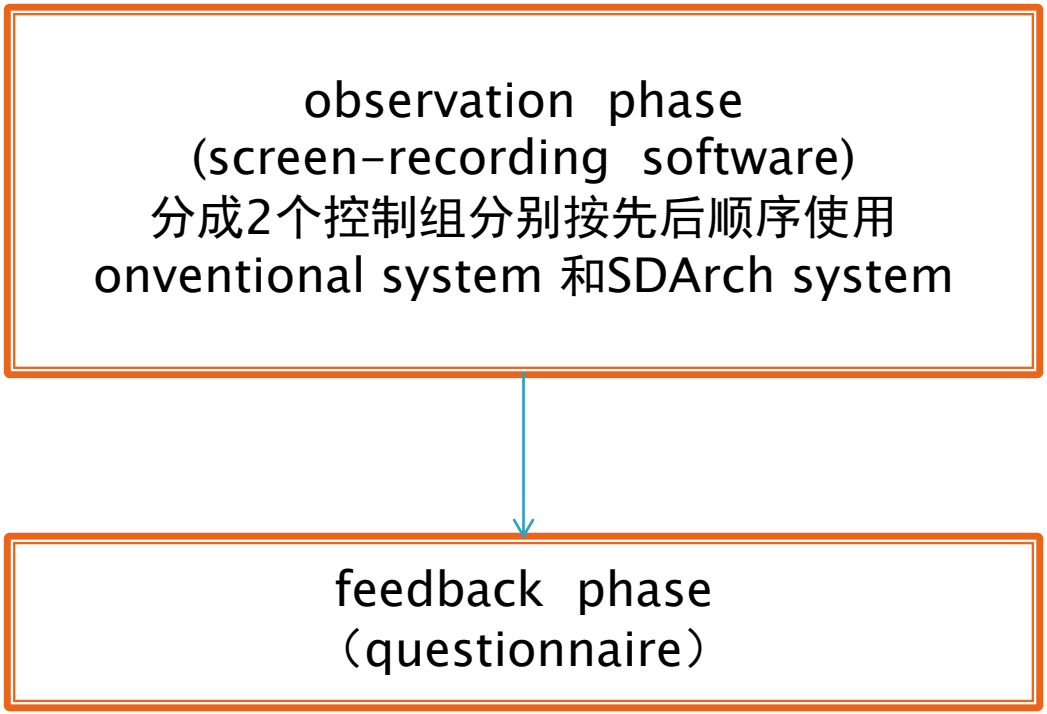
4. participants transform and publish some of Office documents to the group's semantic document repository

5. One week after initiated the software design patterns group, the total number of the shared sds reached 50 documents

created a simple web-based file upload form application
and upload the original office documents for **the conventional system**

Conducting the Evaluation

- 评价过程包括2个阶段



Conducting the Evaluation

- 问卷包括9个问题，采用5-level Likert scale (Gediga et al., 1999)，S1-S5 收集对系统使用的主观性评价，S6评价学习易用性，评价系统易用性，

S1: Using the SDArch services and SemanticDoc tools enables me to accomplish tasks more quickly;
S2: Using the SDArch services and SemanticDoc tools increases my productivity;
S3: Using the SDArch services and SemanticDoc tools improves the quality of the work I do;
S4: Using the SDArch services and SemanticDoc tools makes it easier to do my work;
S5: Overall, I find the SDArch services and SemanticDoc tools useful in my work;
S6: Learning to operate the SDArch services and SemanticDoc tools is easy for me;
S7: I find it easy to get the SDArch services and SemanticDoc tools to do what I want them to do;
S8: Interaction with the SDArch services and SemanticDoc tools is clear and understandable;
S9: Overall, I find the SDArch services and SemanticDoc tools easy to use.

Evaluation Results

- 任务完成时间

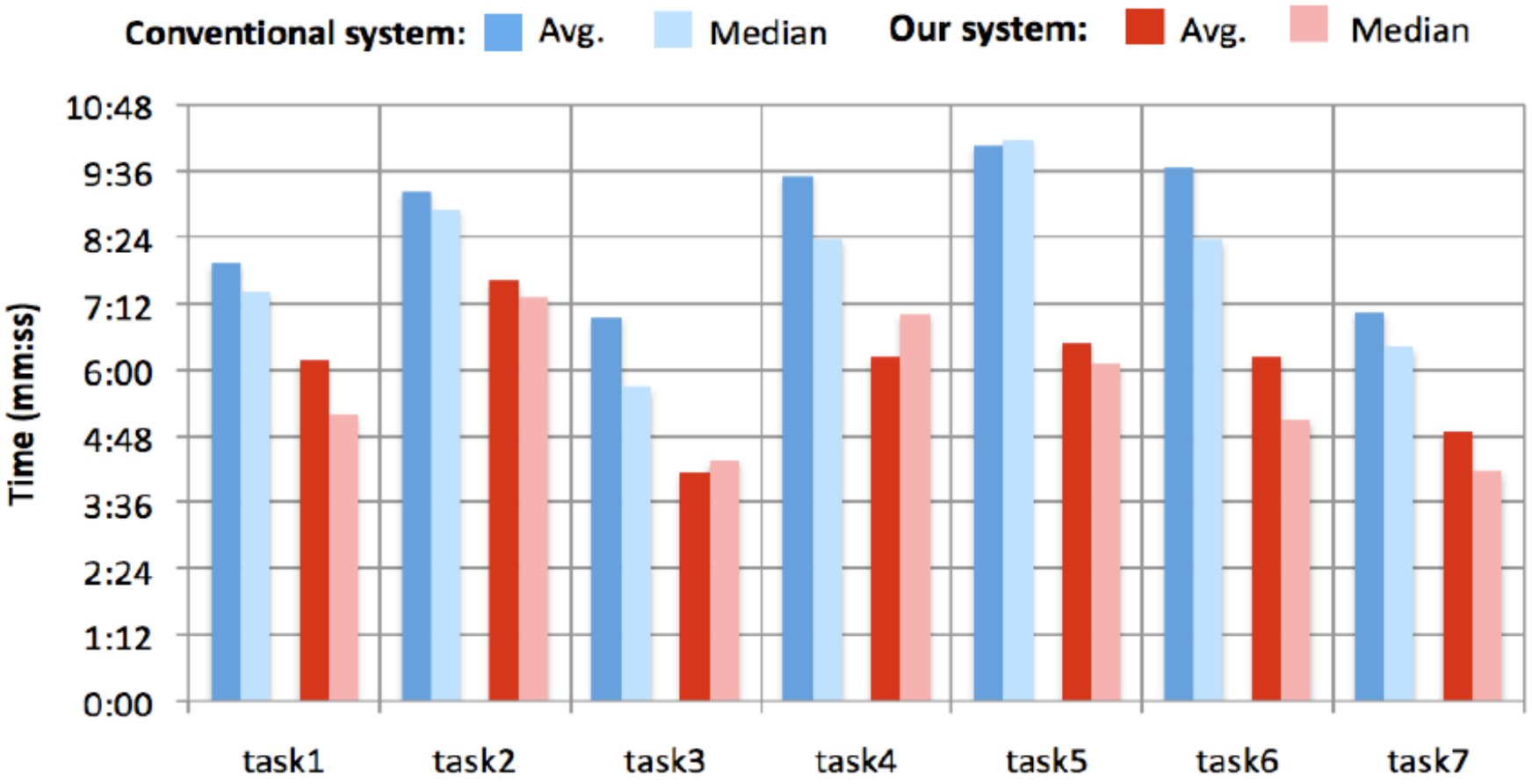


Figure 5. Average and median task completion times

Evaluation Results

- 任务完成时间统计、t检验

Table 2. Tasks completion times' statistics

Task	Conventional System			SDArch System			Relative Performance		t-test p(T<=t)
	Avg.	Median		Avg.	Median		Avg.	Median	
1	7:56	7:25	0:52	6:10	5:12	1:56	77.7%	70.1%	0.0031
2	9:14	8:54	0:32	7:37	7:19	0:48	82.5%	82.2%	0.0022
3	6:58	5:41	1:23	4:08	4:21	1:02	59.3%	76.5%	0.0045
4	9:31	8:22	1:07	6:14	7:00	1:12	65.5%	83.7%	0.0007
5	10:04	10:10	0:34	6:30	6:06	0:32	64.6%	60.0%	0.0027
6	9:41	8:21	1:14	6:15	5:06	0:33	64.5%	61.1%	0.0004
7	7:03	6:24	0:39	4:52	4:10	1:27	69.0%	65.1%	0.0014

Evaluation Results

- 鼠标点击次数统计

Table 3. Mouse clicks statistics

Task	Conventional System			SDArch System			Relative Performance		t-Test
	Avg.	Median	σ	Avg.	Median	σ	Avg.	Median	p(T<=t)
1	124.3	107	14.23	108.3	93	15.32	87.1%	86.9%	0.0003
2	137.2	118	15.31	109.2	102	9.30	79.6%	86.4%	0.0048
3	128.4	122	11.42	96.7	84	8.42	75.3%	68.8%	0.0001
4	141.9	124	19.21	112.0	104	11.52	78.9%	83.8%	0.0023
5	152.0	133	16.73	77.7	71	7.32	51.1%	53.3%	0.0022
6	144.6	136	10.82	82.6	77	6.80	57.1%	56.6%	0.0007
7	122.5	109	18.34	98.5	94	5.32	80.4%	86.2%	0.0026

Evaluation Results

- 窗口切换统计、t检验

Table 4. Window switches statistics

Task	Conventional System			SDArch System			Relative Performance		t-test
	Avg.	Median	σ	Avg.	Median	σ	Median	Avg.	p(T<=t)
1	20.4	12	7.04	4.4	4	1.45	33.3%	21.5%	0.0041
2	17.3	15	3.22	6.2	4	1.82	26.6%	35.8%	0.0032
3	21.6	17	4.54	5.2	5	1.37	29.4%	24.0%	0.0009
4	23.2	18	5.21	6.6	5	2.32	27.7%	28.4%	0.0015
5	21.8	19	3.18	5.6	4	2.41	21.0%	25.6%	0.0023
6	22.4	19	3.71	6.3	5	1.62	26.3%	28.1%	0.0042
7	18.5	14	5.57	4.0	4	0.82	28.5%	21.6%	0.0028

Evaluation Results

- 用户主观评价

Table 5. Subjective user feedback for the SDArch system

Statement	S1	S2	S3	S4	S5	S6	S7	S8	S9
Average	4.7	4.3	4.1	4.7	4.8	4.7	4.3	4.6	4.8
Median	5	4	4	5	5	4	4	4	5

Conclusions

- 实证研究表明语义网技术和社会网络为创作过程提供有效支撑。未来做长时间、多用户评价及复杂的采集数据分析。

Although the use of semantic web technologies and social networking in the authoring of learning content has been studied extensively over recent years, the real benefit they brought to the authoring process is still unclear. Up to what extent these innovative technologies can improve the effectiveness and efficiency of authors in carrying out authoring tasks is a question that still seeks an answer. In our opinion, the right answer to this question can be obtained through an empirical study conducted with an authoring system that is featured by these technologies. In this paper, we presented the results of one such empirical study that we conducted to investigate the benefits of the novel, semantic document architecture (SDArch) with respect to the authoring of the course material. Since semantic web technologies and social networking are two pillars of SDArch, the benefits of SDArch naturally extend to them. Based on objective, quantitative measures of user effectiveness and efficiency, and the users' subjective feedback, we found that the use of semantic web technologies and social networking results in improvements of the authoring of the course material compared to the conventional authoring approach. In the future work, we plan to perform a new, long-term evaluation study with more participants and a larger document collection. We also plan to consider the application of some other evaluation metrics, in addition to those applied in this study, as well as to provide more comprehensive statistical analysis of collected data.

反思与启示

- 该文提供了较为完整和深入的实证研究的范例。
- 提供了特色系统设计与描述框架。
- 提供了两个系统的比较方法。
- 定量分析与定性分析相结合的评价方法。
- 文章写作思路、组织结构方面的值得借鉴。

THE END

Thanks !