

TOWARDS TO SOFTWARE IMPLEMENTATION OF KNOWLEDGE MAPS*

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This paper deals with various ways of knowledge maps software implementation. There are discussed both freeware and commercial products. Based on this comparison, we argue for the approach based on ontologies and present our own software “Selides”. Ontological specification is of particular interest to knowledge managers because associated methods support top management in the processing of tacit knowledge into a more explicit form. The goal of our project is to work with knowledge using computer technology. This approach is related to the database technology and can significantly improve the knowledge management in contrast to raw work with volumes of text and graphics.

knowledge engineering; knowledge representation; knowledge map; software support; ontology

INTRODUCTION

Knowledge mapping is a discipline that is concerned with the design and engineering of technologies that allow advanced organization, filtering and management of information in visual ways. Computer programs are an ideal environment for creating and processing this visual information. Basically, there are two approaches. First approach deals with usage of universal graphical editors such as MS Visio or another vector-based drawing tool. Second approach deals with special software where are concepts stored in database together with their graphical features. In this paper, we argue for the second approach.

MATERIAL AND METHODS

We have carried out the analysis of existing software systems in period 2006–2007. Moreover, our group is interesting in object-oriented programming technology in last 10 years. In this paper we present “the state of the art” in area of computer programs aimed for knowledge mapping. Secondly, our own approach inspired by traditional methods of software engineering and ontology-based knowledge representation has been used on the practical software development project.

Knowledge Mapping

To authorities, the concept of *Knowledge* is a set of data and information, to which is added expert opinion and experience, to result in a valuable asset which can be used

or applied to aid decision making. Knowledge may be explicit and/or tacit, individual and/or collective (Tandukar, 2007). Another important concept we deal with is the concept of *Knowledge Management*. According to popular *Wikipedia* we agree with an assertion that Knowledge Management (*KM*) comprises a range of practices used by organizations to identify, create, represent, and distribute knowledge for reuse, awareness and learning (Knowledge Management, 2007). Now, we focus on the most important technological problem connected with implementation of knowledge management – how we discover, organize, represent and efficiently store the information associated with knowledge. The process, how to do this, is known as the *Knowledge Mapping* and conceptual form of knowledge representation is known as the *Knowledge Map*.

According to Vestal (2007) the Knowledge Mapping is a process by which organizations can identify and categorize knowledge assets within their organization – people, processes, content, and technology. There exist many different kinds of possible visualization of knowledge information. One most important method is so-called the *Knowledge Map* or *Mind Map*. Conformably to Wikipedia (Mind Map, 2007) the Mind Map or Knowledge Map is a diagram used to represent words, ideas, tasks or other items linked to and arranged radially around a central key word or idea. It is used to generate, visualize, structure and classify ideas, and as an aid in study, organization, problem solving, decision making, and writing. An illustration of such mind map is in Fig. 2 taken from (Mind Map, 2007).

Generally, the process of knowledge mapping is not too far from the activity of conceptual modeller in soft-

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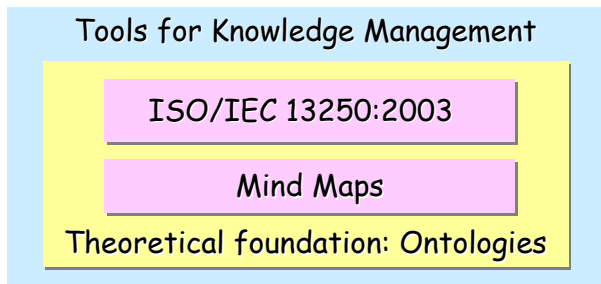


Fig. 1. Tools for Knowledge Management

ware engineering. The Mind Map designer must usually perform following steps.

- Identify type of knowledge needed to do my work.
- Who provided it, where do I get it, what is the format of it.
- Identify a structure of knowledge, entities, attributes and association between them.
- What is the timeline of knowledge? Which part of knowledge precedes other parts?
- Identify resources need to fulfil resultant knowledge.

DISCUSSION

There exist many different software tools for creating *knowledge maps*. Some of them are open source or free-ware and other tools are commercial products as well. Here we present a brief description of three well-known mind mapping tools; an open source FreeMind (FreeMind, 2007) and commercial MINDMAP (ConceptDraw, 2007) and SmartDraw (SmartDraw, 2007). A *knowledge map* is a visual-based representation used to display words, ideas, tasks or other items mutually linked into one system.

Software knowledge mapping tools are programs used to elicit ideas from one or more users by placing a topic in the centre of an empty space and branching out with related ideas. The main goal of this software technology is that it will help experts to organize, link, and integrate thoughts. The graphical user interface of knowledge mapping tools involves making an arrangement of concepts, attributes and relationships into a visual hierarchical structure (picture or tree). In this visual structure, concepts and attributes are displayed as nodes having lines or arrows representing relationships among these concepts. There is the standard formally known as ISO/IEC 13250:2003.

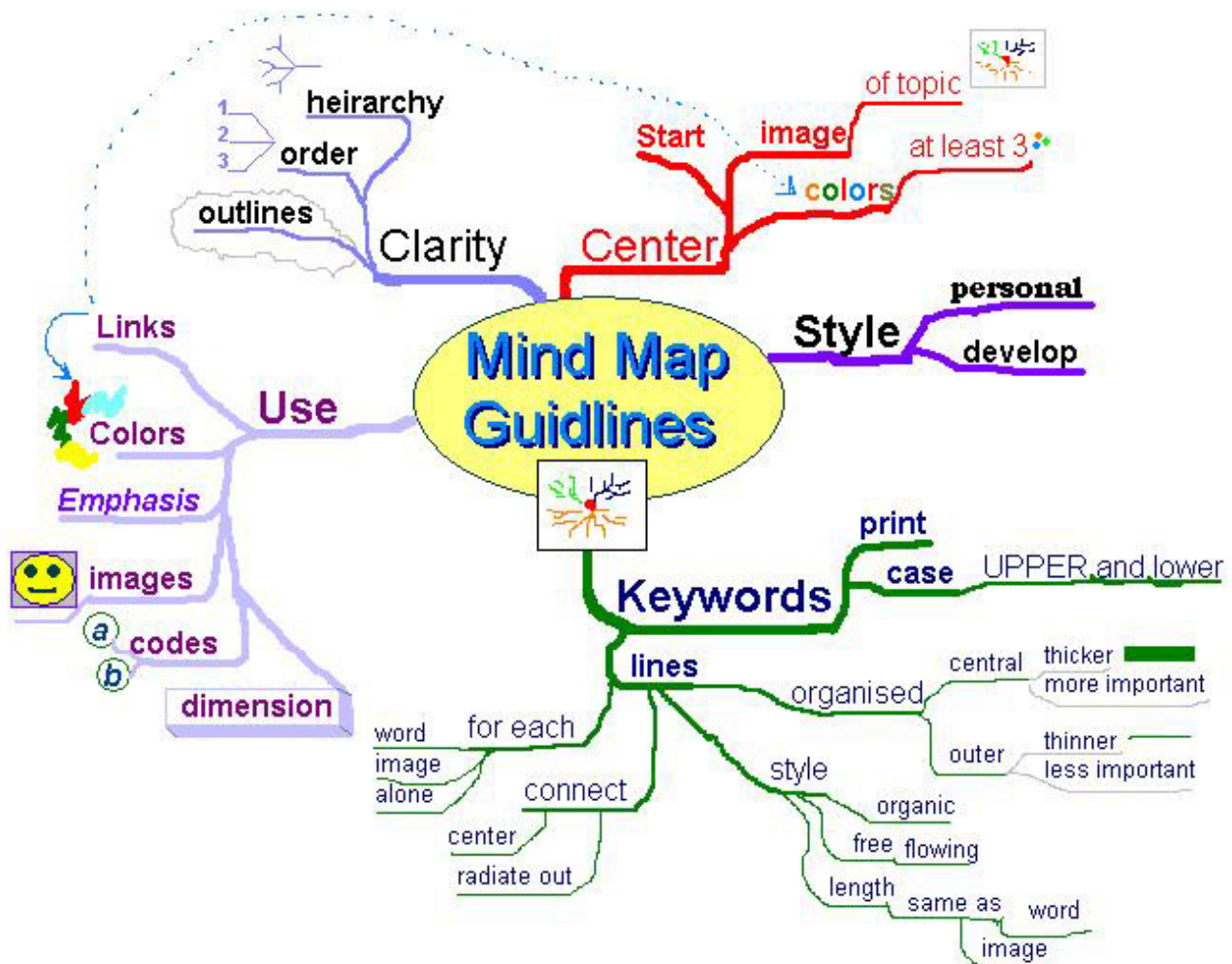


Fig. 2. Illustration of Mind Map

Mind mapping software can be used for brainstorming, problem capturing, knowledge representation etc. This information can be subsequently edited, processed, prioritised and elaborated in another computer tools such as databases, workflow systems, communication software etc.

Free Mind

The FreeMind as described in FreeMind (2007) is free-ware mind-mapping software written in Java and licensed under the GNU General Public License. The 0.9.0 beta 13 released 2 Sep 2007 version was published in September 2007. Most notable features of FreeMind are folding of branches, export to HTML, XHTML, PNG, JPEG, SVG and PDF, icons on nodes, clouds around branches and web and file link nodes. There exists also the possibility to integrate the FreeMind mind maps into the Wiki engines, for example TikiWiki, DokuWiki and JSPWiki and to the certain CMS systems, such as Drupal. There exist also preinstalled packages for most popular OS e.g. Microsoft Windows, MAC OS X and Linux. An illustration of appearance of the mind map created in the FreeMind is shown in Fig. 3.

Mind Map

The ConceptDraw MINDMAP 5 (ConceptDraw, 2007) is a commercial product of Computer Systems Odessa Software Corporation. CS Odessa offers a product line of Macintosh and Windows compatible visual software products. The notable features of MINDMAP 5 are possibilities of working with multi-page mind maps, support for group collaboration, rich customization of graphical appearance and export to HTML, PDF, Microsoft PowerPoint file formats and many popular picture file formats such as BMP, JPEG, TIFF, etc.

Smart Draw

The SmartDraw (SmartDraw, 2007) is a chart and graphics editor developed by SmartDraw.com; one of the most popular business graphic software producers. SmartDraw is used to create business graphics such as flowcharts, organisation charts, Gantt charts, timelines, floor plans and other diagrams. Another such program of this sort is, for example, the Microsoft Office Visio. The possibility to create mind maps is only one of many other abilities of this commercial product. The most prominent feature of this professional package is a very good graphical appearance and bundling with other diagrammatic tools.

Fig. 3. Freemind

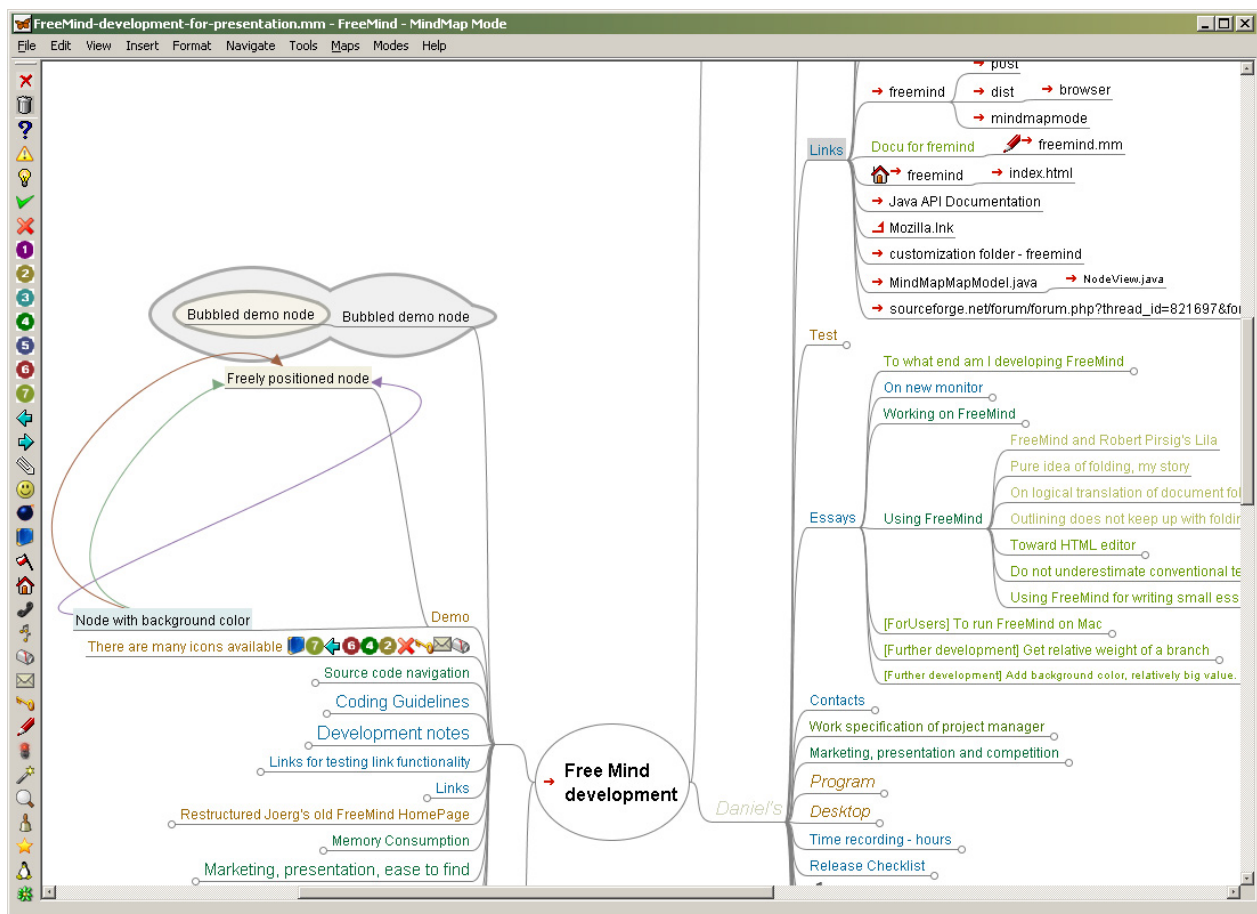
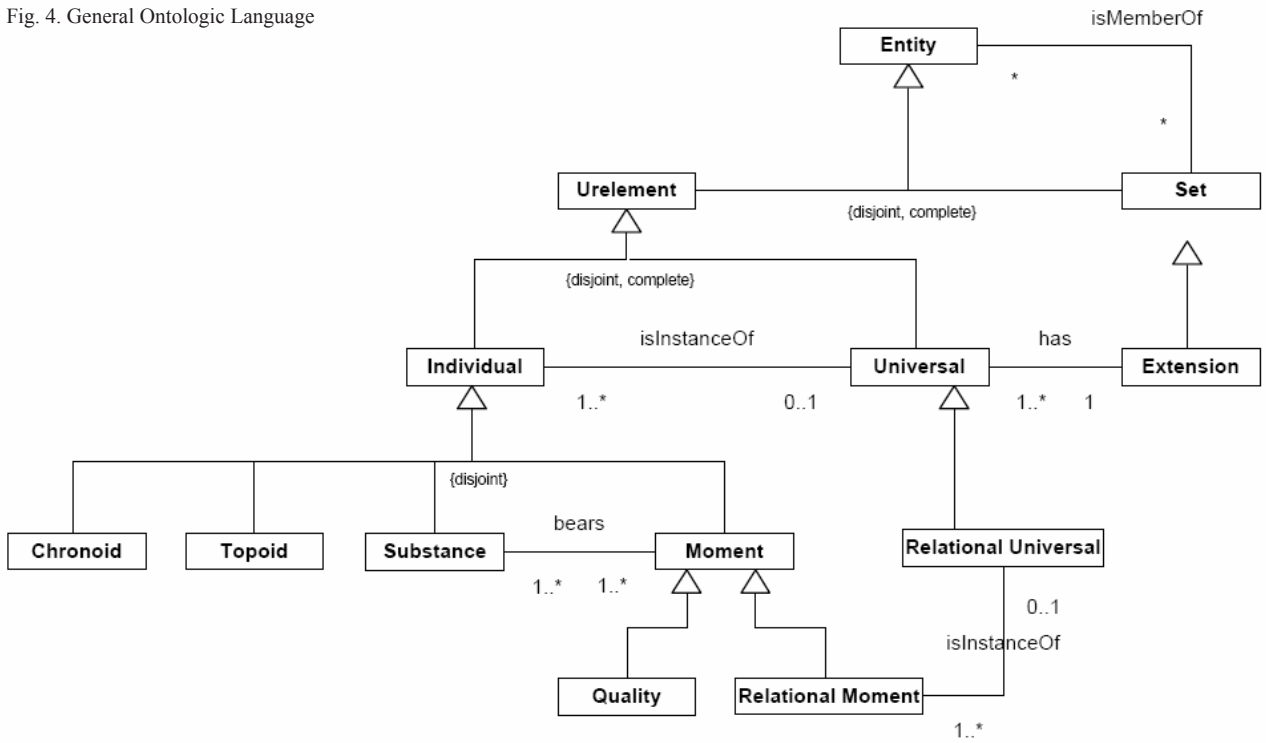


Fig. 4. General Ontologic Language



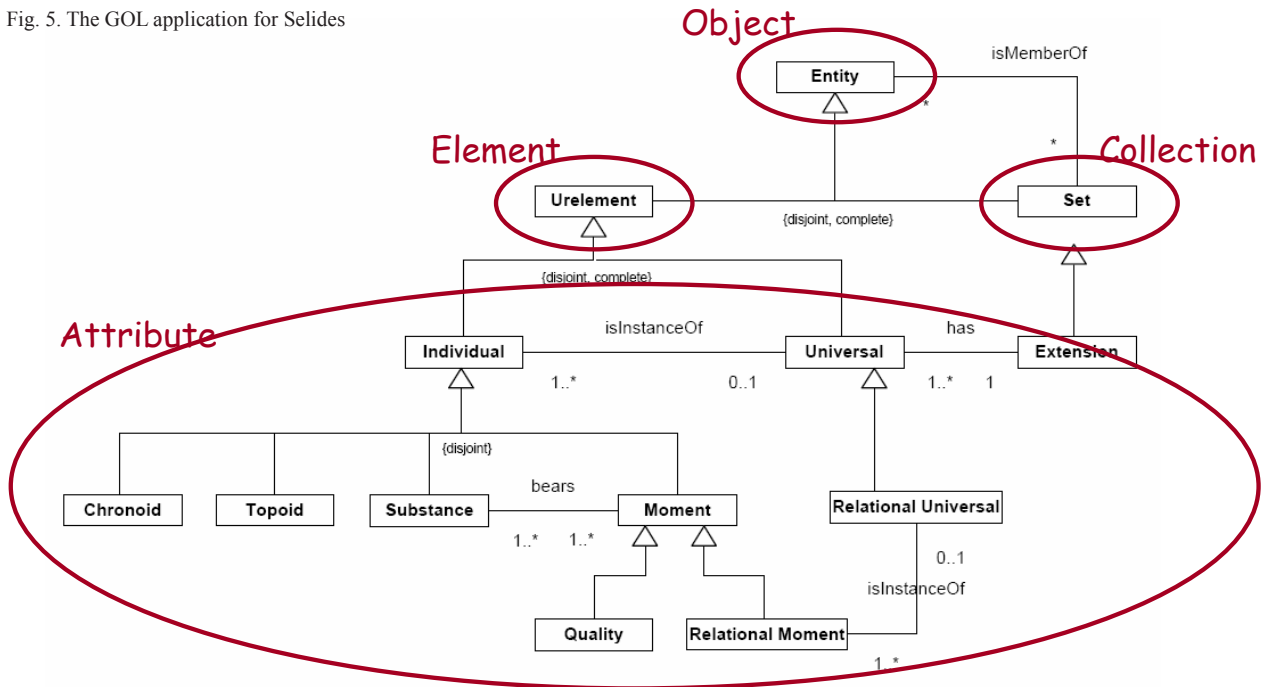
RESULTS

In both computer science and information science, ontology is a data model that represents a set of concepts within a domain and relationships between those concepts. It is used to reason about the objects within that domain. In computer technology, ontologies share many structural similarities, regardless of the language or standard in which they are expressed.

Ontology based implementation of knowledge map

Ontological modelling is concerned with capturing the relevant entities of a domain in ontology of that domain using an ontology specification language based on a small set of basic, domain independent, ontological categories. While conceptual modelling languages (such as Entity-Relationship diagrams or UML diagrams) are evaluated on the basis of their successful use in information systems

Fig. 5. The GOL application for Selides



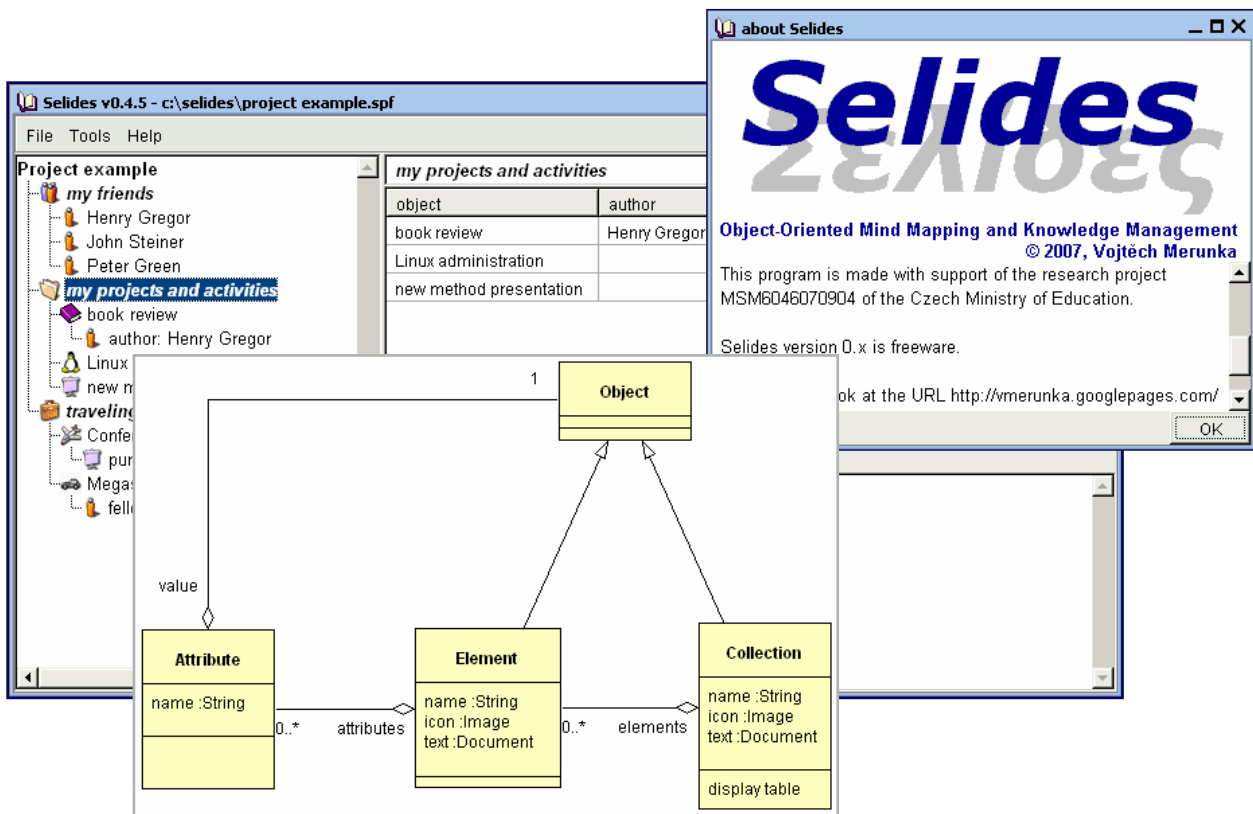


Fig. 6. The conceptual model of Selides

development, ontology specification languages and their underlying upper-level ontology have to be rooted in principled philosophical theories about what kinds of things exist and what are their basic relationships with each other.

The ontology language is a formal language used to encode ontology. There are a number of such languages, both proprietary and standards-based (OWL, CycL, KIF, RIF, GOL...). We adopted the General Ontological Language (GOL), proposed in (Degen et al., 2001), for data model of our modelling tool. The upper level ontology of GOL is under development at the "Institute for Formal Ontology and Medical Information Science" at University of Leipzig, Germany (<http://www.ifomis.uni-leipzig.de>). The project is collaboration between philosophers, linguists and other cognitive scientists and of course computer and information scientists. As Fig. 4 shows, GOL has very complex structure, which can be simplified for concrete purposes. This is our way of implementation (Fig. 5).

Selides – tool for general Knowledge Mapping

The word "selides" is a Greek word meaning "pages". Selides is multi-page mind mapping and memo management software. Selides version number 0.x is freeware and can be downloaded from web-address <http://vmerunka.googlepages.com/selides>.

Selides uses the object-oriented database based on four classes: Object, Element, Collection and Attribute. Ele-

ments and collections are subspecies of objects. Each collection consists from set of objects; each object can have other objects as its attributes. The whole structure of this data model is in Fig. 6.

Selides is written in programming language Smalltalk using development environment VisualWorks. First implementations have been compiled for MS Windows operating system. (Fig. 7.) Selides reassumes our previous research in the pure object-oriented approach for software development. using BORM methodology. Hence it is developed using BORM methodology (Knot et al., 2003). Program Selides allows loading and storing of the whole project or selected subsets. Objects are displayed in tree (left pane of the application), details of selected objects are displayed as forms (right pane of the application).

Selides differs from other similar programs in three ways:

1. *Object sharing.* The same object can be present in more roles in the system. Selides differs between simple copying of objects and between more occurrences of the same object, e.g., in Fig. 8 is object "Henry Gregor" in three different roles. Other programs usually do not support sharing of objects in general.
2. *Particular elements as independent documents* (Fig. 9). Objects can contain a formatted text, can store several data types and can consist of other objects. Moreover, attribute values can start subsequent actions in the computer like open web pages, send e-mails or start another programs (Fig. 10). Other programs usually

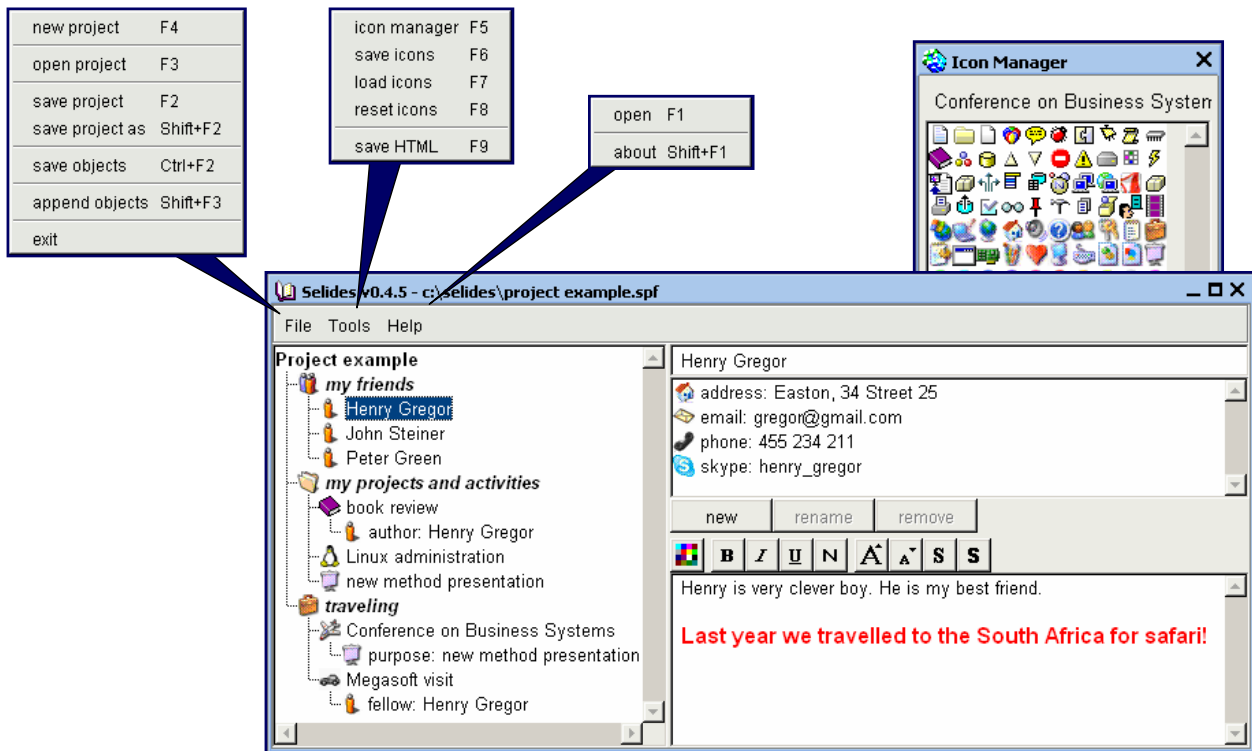


Fig. 7. The graphical user interface of Selides

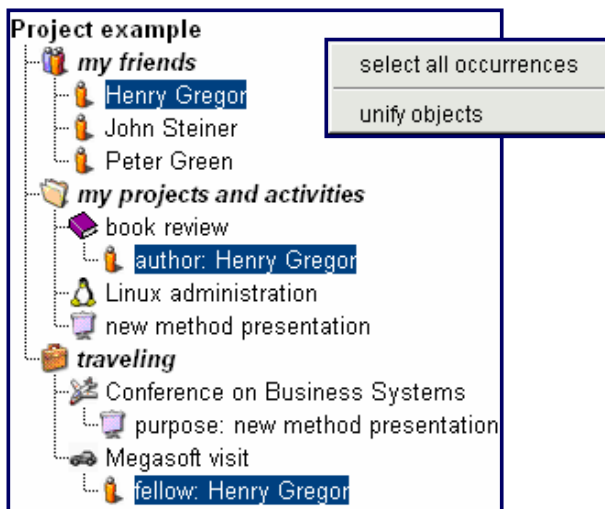


Fig. 8. More occurrences of the same object in Selides

support only short unformatted pieces of text as the only one type of information without any subsequent actions.

3. *Collection support.* Collections can be interpreted as small databases displayed in tabular form. Rows display objects as collection members and columns display domains of properties of these members. User can sort or access objects by arbitrary value from domain. (Fig. 11). Other programs usually do not support collections in any form.

Finally, there is yet one useful feature. Selides allows project storing into collection of HTML files, which can be viewed in any standard web server. This feature allows creation of wide-accessible reports containing finalized information. (Fig. 12).

CONCLUSION

Development of the well-grounded and ontology-based tool is an important step towards to efficacious working with explicit knowledge in computer databases. In this paper we used the General Ontological Language (GOL) and its underlying upper level ontology to create own software modelling tool for knowledge mapping. Moreover, we recognised the advantage about knowledge stored and processed in object-oriented database having visual representation as projection of this database.

Selides can be used in several ways, for example, as a tool for capturing primary knowledge, which would be subsequently refined and processed. Another option is usage as a personal knowledge and mind-mapping tool. We have also good experience with Selides as documentation management tool (manuals, guides, research reports etc.).

Our future work will be targeted to support of various input and output format to provide more interoperability with other similar tool. Also, we will work on algorithmic-based synthesis of knowledge deducible from Selides database.

Fig. 9. An element as a document with attributes in Selides

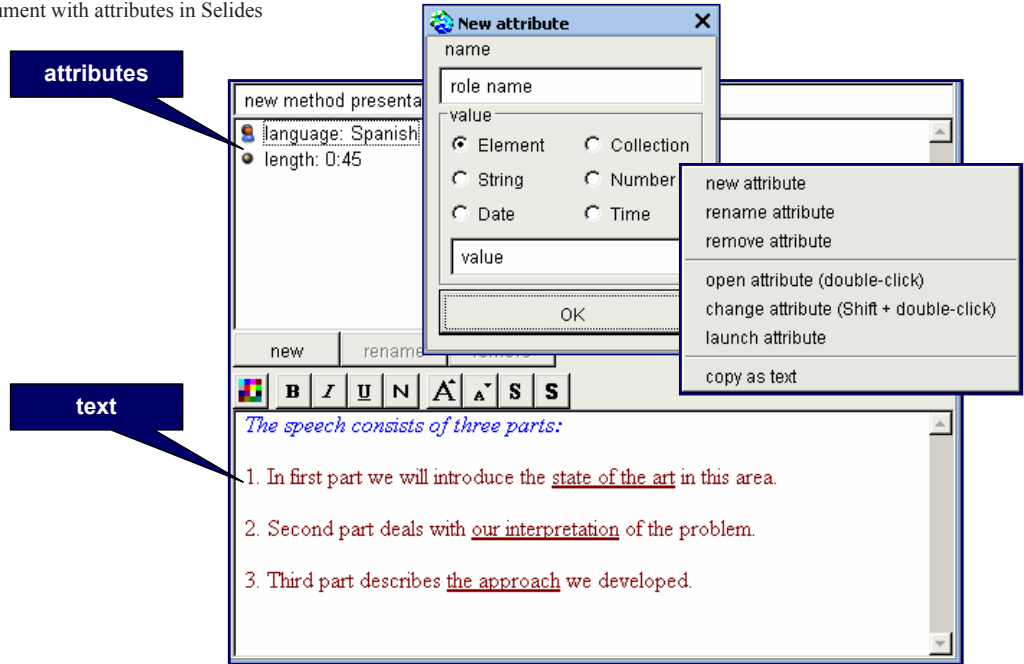


Fig. 10. Actions performed by attribute values in Selides

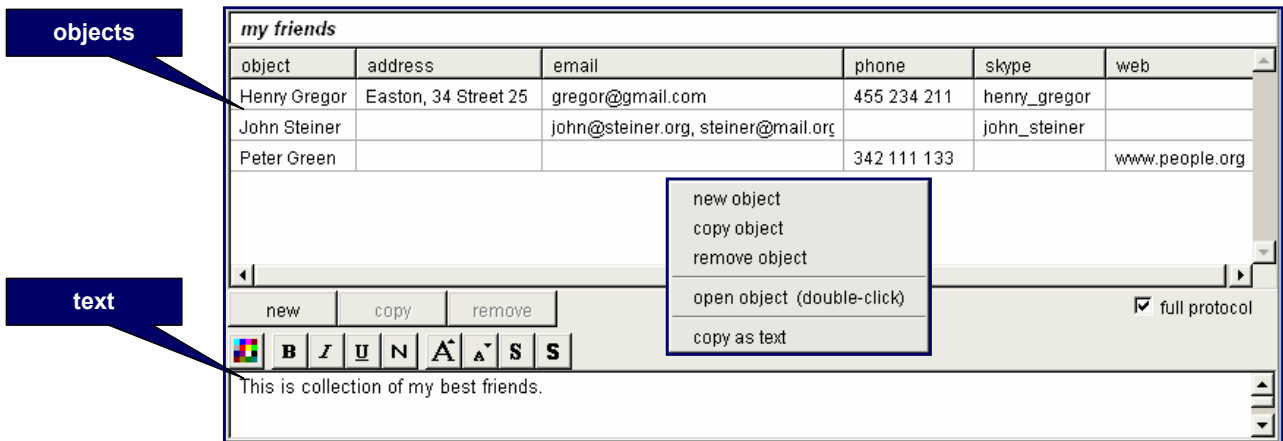
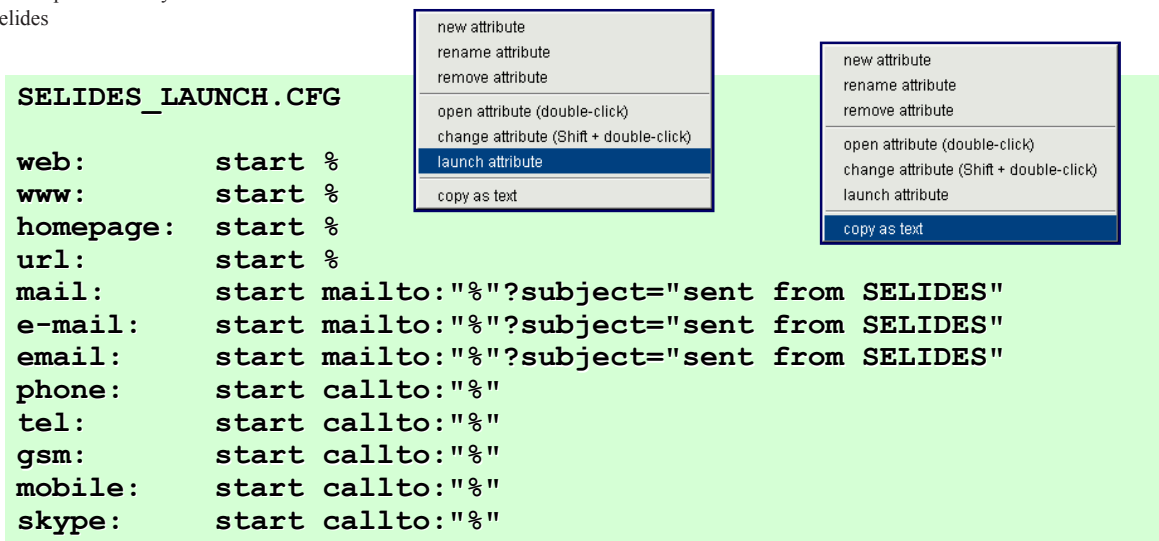


Fig. 11. Collections of elements in Selides

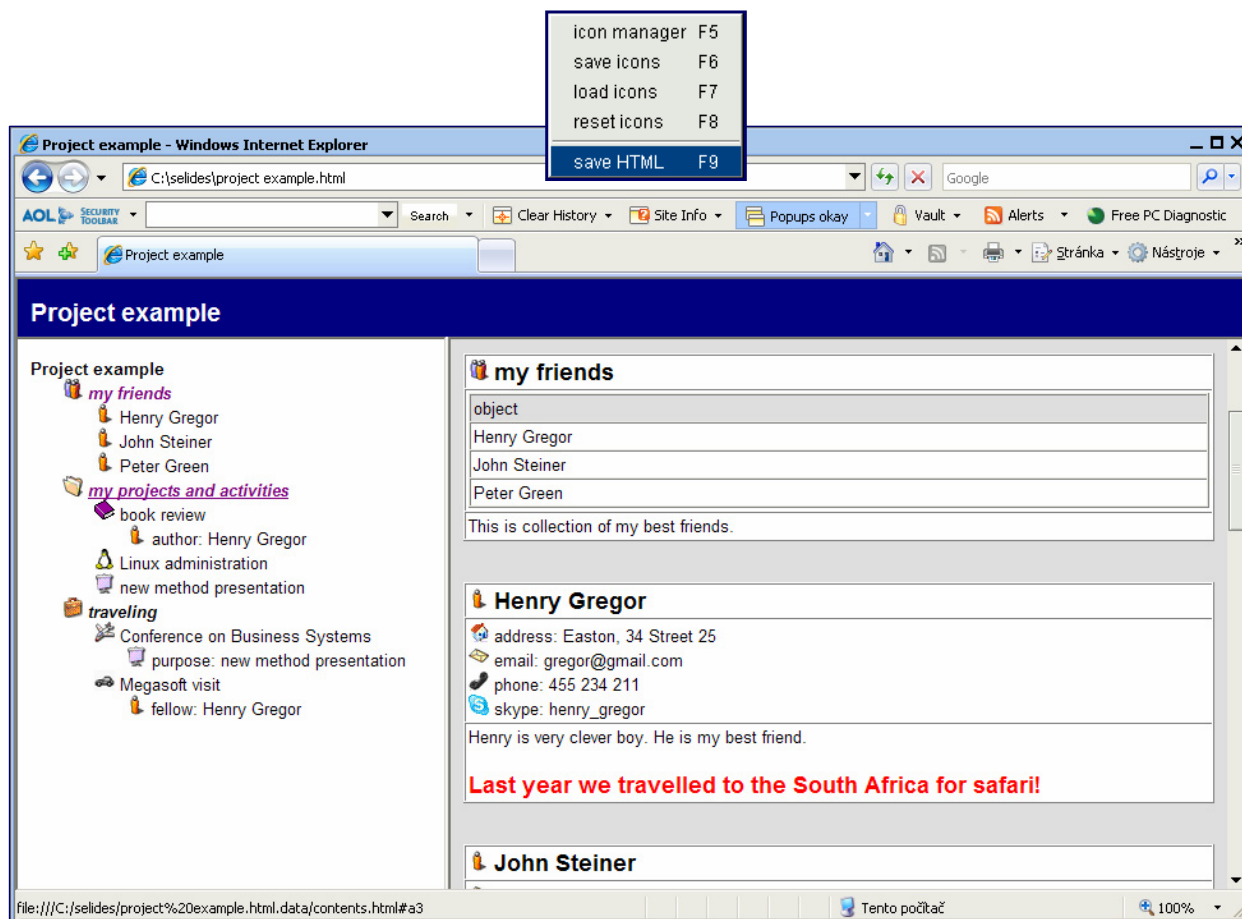


Fig. 12. HTML reporting in Slides

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K softwarové implementaci znalostních map.

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Článek se zabývá různými způsoby softwarové implementace znalostních map. Jsou zde diskutovány vlastnosti nejužívanějších volně dostupných i komerčních programů. Důležitou požadovanou vlastností programů na znalostní mapy je vedle grafických možností také schopnost pracovat s uloženou informací jako s databází. To znamená, že takovou informaci nestačí dokázat na počítači jen nakreslit, ale je třeba ji umět dále zpracovávat. Jde především o doplňování atributů, dotazování nad kolekcemi elementů, manipulace s objekty atd.

Počítačové implementace znalostní mapy lze dosáhnout různými způsoby. Nejjednodušším způsobem, ale také nejméně účinným, je chápání znalostní mapy jako obrázku zpracovaného grafickým editorem. Dokonalejší implementace se různým způsobem opírají o databázovou technologii a datové modelování, kam spadá i oblast ontologií. Proto je v tomto článku popsáno využití ontologií, konkrétně ontologického modelu GOL a jeho využití pro počítačovou implementaci znalostí. GOL i jiné ontologie lze chápat jako formalizovanou reprezentaci struktury pojmů, vztahů a atributů určité problematiky. Ontologie může sloužit jako nástroj, který se používá k uchování a předávání znalostí týkající se určité konkrétní problematiky. Datové struktury vymezené ontologií se potom naplňují v konkrétních úlohách konkrétními údaji.

Podle těchto zásad byl sestaven vlastní program „Selides“. Tento nástroj je využitelný pro prvotní sběr a zpracování dat nebo jako personální záznamník či nástroj na tvorbu strukturované dokumentace (příručky, výzkumné zprávy,...). Budoucí vývoj programu se zaměří na výměnu dat s jinými nástroji a syntézu znalostí odvoditelných z databáze.

znalostní inženýrství; reprezentace znalosti; znalostní mapa; softwarová podpora; topologie

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