REWERSE – Annual Public Report 2006

Reasoning on the Web with Rules and Semantics

http://rewerse.net

The European Network of Excellence REWERSE develops rule-based languages and applications to process, query and to automatically reason over Web data. REWERSE's technologies thus enhance today's conventional Web towards a more intelligent "Semantic Web". REWERSE's focus on *rules and reasoning* on the Web enhances existing Semantic Web efforts that mainly deal with the *representation* of semantic information. REWERSE networks more than 100 researchers that work on three main objectives: to develop a set of inter-operable, application independent rule-languages supporting various forms of Web reasoning, to provide support tools for reasoning on the Web like rule modelling, verbalization or visualisation, and to test these technologies on various Semantic Web application domains like personalisation, reasoning with time and space or with Bioinformatics data. To foster durable impact REWERSE realises Education and Training activities targeted at Universities as well as Technology Transfer and Awareness activities targeted at European industry. As a W3C member REWERSE is involved in various standardisation activities.

Summary of Activities

Reasoning Languages and Applications

The focus of REWERSE's research activities is the definition of languages and support tools for reasoning on the Web and the application of these technologies in different application domains. In the first year, REWERSE has defined requirements and base components for the different technologies accompanied by thorough state-of-the-art surveys and use-cases. In the second year, REWERSE has defined basic parts of the languages and has implemented first prototypes of the respective technologies. In the past third year the REWERSE working groups I1 to I5 have consolidated the language definitions and have implemented fully functional prototypes of, in particular, the following languages .

I1 Rule Modeling and Markup: *R2ML*, the REWERSE Rule Markup Language, and *URML*, a UML-based visual Rule Modelling language with the visualisation tool *Strelka*.

I2 Policies: *Protune* (Provisional trust negotiation), the trust and policy negotiation framework of REWERSE, and *ACE* (Attempto Controlled English), a controlled natural language for knowledge representation.

I3 Composition and Typing: *Typing system* for Xcerpt, and the *Reuseware Composition Framework* toolset which provides composition technology specifically for languages in the context of the Semantic Web, such as OWL, Xcerpt, XQuery.

I4 Reasoning-aware Querying: *Xcerpt*, a versatile rule-based Web query language, its abstract machine *AmaXos*, and the prototype *dlvhex*, a reasoner for HEX-programs with the goal to neatly extend existing ontologies with rules and reasoning.

I5 Evolution and Reactivity: the prototype *r3* (Resourceful Reactive Rules) providing a general Semantic Web rule engine for reactive rules, and *XChange*, a declarative high-level reactivity language (enhancing Xcerpt).

As for advanced Web applications the following languages and prototypes have been developed and extended in year 3 by the application groups A1 to A3:

A1 Time and Location: *GeTS* (GeoTemporal Specification Language). its spatial counterpart, the language *MPLL* (multiparadigm locational language), and a number of below listed peripheral systems and applications showcasing main results.

A2 Bioinformatics Semantic Web: *GoPubMed.org*, an intelligent literature search engine, and a further applications that for example implement constraint satisfaction for sequence alignment, reasoning over metabolic pathways, integration of online biological data, automated integration of biomedical ontologies and others.

A3 Personalized Information Systems: the *Personal Reader Framework*, which implements a service-based architecture for providing various personalization functionalities on the Semantic Web, developed components are the award-winning *Personal Publication Reader*, the *Personal Reader Agent* and others.

Dissemination

In year 3 REWERSE has held three major dissemination events: the second "Reasoning Web" Summer School (September 2006, Lisbon, Portugal), the research workshop "Principles and Practice of Semantic Web Reasoning" (PPSWR 2006) (June 2006, Budva, Montenegro) and a number of industry awareness events, for example an exhibition at the "Semantics 2006" (November 2006, Vienna, Austria). As for standardisation REWERSE has been actively shaping results and activities of the W3C Rule Interchange Format (RIF) Working Group and is increasingly involved in other W3C activities. REWERSE has continued its high publication activity with a total of over 370 internationally reviewed REWERSE related publications at month 32 of the project. A number of workshops and tutorials on REWERSE related topics complete the successful dissemination activities of REWERSE. Emerging co-operations with new FP6 projects, for example the project MUSING, complemented existing co-operations with, for example, the project Knowledge Web.

Spin-off Company

The prototype GoPubMed developed by the A2 Bioinformatics group has lead to the spin-off of Transinsight GmBH, which received seed funding by the Hightech Gründerfonds in Germany.

Integration

The collaboration within REWERSE has cross-fertilized the languages and applications of the different working groups and has lead not only to interesting applications (for example, using the controlled natural language ACE developed by I2 for text-mining of biomedical literature as investigated by A2), but also to important technical improvements of the languages (for example, typing of I3 can be used to optimize I4's Xcerpt engine) – to mention just a few examples. In the final year of REWERSE further prototypical integration of results of the different working groups will be worked on.

Position of REWERSE

In its first 3 years REWERSE has proved to be a highly productive research-oriented Network of Excellence (NoE) on Reasoning on the Web. As a research-oriented NoE REWERSE is an extremely appropriate tool for positioning European Computer Science research in international transfer activities. REWERSE has been the first "joint venture"

on rules on the Web which started 2 years before the W3C initiated the RIF activity on this very same field, in which REWERSE is now actively involved. As for dissemination, in particular REWERSE's *Reasoning Web* Summer Schools, the *Semantic Web Days* and the research Workshops *PPSWR* have proven to be excellent platforms for training of young researchers, for spreading novel issues to industry and for bringing various research issues fruitfully together. For the next year REWERSE plans to continue these lines of activities with a particular focus on bringing its results, languages and prototypes to the public. A further goal will be to initiate activities that guarantee a continuation of some of the activities beyond the formal end of REWERSE.

Important Work Areas

The network REWERSE focuses on three core work areas: research on Web reasoning languages and their processing, advanced Web applications requiring reasoning, and knowledge dissemination activities spreading the results to a broader audience. A tight synergy between the different work areas is taking place.

Work Area: Web Reasoning Languages and Their Processing

REWERSE integrates five research oriented working groups on Web reasoning languages and their processing.

Rule Modelling and Markup (I1). It is increasingly important to make applications like car rental systems or mortgage loan offer systems available on the Web. The processes underlying these systems are often built on the basis of business vocabularies and business rules. In order to bring the systems to the Web the vocabularies and rules have to be formulated in a suitable machine-processable way and reasoning mechanisms that can be *automatically* executed on the Web have to be defined.

The REWERSE working group I1 on "Rule Modelling and Markup" is developing tools and finally an integrated framework for modelling, visualisation, verbalisation and markup of rules. With these tools and technologies the practical use of rule formalisms on the Web is facilitated. The focus of the group lies on rule markup languages, which are the common basis for defining various concrete application-specific rule languages. Rule markup languages will play a central role on the Web and in distributed systems since they allow deploying, executing, publishing and communicating rules on the Web, or to exchange rules between different systems and tools.

The group I1 also focuses on expressing vocabulary, facts and rules in one *visual* model for ease of usability for the end-user. Ideally, facts and rules also have to be *verbalised* for non-experts, and finally a suitable markup language is needed to publish vocabularies and rules on the Web, and to exchange them between different systems and tools.

In 2006 the group I1 has mainly worked on R2ML, the REWERSE Rule Markup Language, and URML, a UML-based visual Rule Modelling language. Furthermore the group has developed a verbalization component for the rule markup language R2ML. The group has defined necessary language extensions and has released demonstrators for the languages available, see http://rewerse.net/I1/.

More concretely, R2ML is a comprehensive and user-friendly XML rule format that allows interchanging rules between different systems and tools, enriching ontologies by rules, connecting other rule systems with R2ML based tools for visualisation, verbalisation, verification and validation. The demonstrator R2ML 0.4 has been released in Au-

gust 2006. Furthermore, I1 has developed the semi-visual rule modelling language URML enhanced with a modelling tool Strelka. The modelling language used in the communication between business/domain analysts and business/domain experts for analysing and documenting system requirements must not be 'technical' but should allow (semi-)visual and/or natural-language-like rule expressions, which can be understood by business/domain experts without extensive technical training. URML offers such a semi-visual (diagrammatic) language for information modelling allowing a limited number of embedded rule types The Strelka tool supports the visual modeling of various types of rules. The rules captured with Strelka can be mapped from the URML metamodel into R2ML XML markup. URML and Strelka will facilitate advanced ontology engineering in particular and ontology/rule-based software engineering in general.

In the upcoming months the group plans to work on tool improvements and extensions. Furthermore, the group intends to make a case study using the rule modelling tool Strelka with the verbalisation and XML rule code generation components in connection with a rule-based decision support or policy implementation resp. enforcement system.

Policy Specification, Composition and Conformance (I2). Granting a user access to a restricted Web service (e.g. downloading restricted project information) or performing a transaction on the Web (e.g. an order in a Web store) requires mutual interaction and trust between systems and users. The rules for establishing trust are often called *policies*. For example the system might implement a policy "Only persons that are at least 18 years hold will have access". Granting access to the user requires the user's input about his/her age. To improve service usability, many of these interactions will be controlled automatically. This requires suitable languages to express and intelligent tools and systems to process and reason with policies, to generate dialogues, and to adapt the system behaviour to different situations.

The group I2 on "Policy Specification, Composition and Conformance" develops methodologies, languages and tools for specifying, enforcing, and integrating heterogeneous policies (for example security policies, privacy policies or business rules). The challenge is to reach an appropriate level of trust in systems and users under the extreme flexibility and interoperability requirements posed by modern business models, application scenarios, and software architectures. The research interests of the group include strongly related issues such as policy languages for access control and sensitive information release, trust negotiation, cooperative enforcement, natural language specifications and explanation facilities. The formulation and automated processing of controlled natural language specifications is of interest to several other working groups in REWERSE, and became a major research track within the working group I2.

In 2006 the I2 group has worked on Protune (Provisional trust negotiation), the trust negotiation framework of REWERSE. Protune is a rule-based policy language and policy-based negotiation framework. A beta version of Protune will be released on sourceforge approcimately by beginning of 2007 (http://rewerse.net/I2/software.html). More specifically, the group has studied the impact of policy protection on negotiation success by using an abstract framework, covering a wide spectrum of strategies and criteria for terminating negotiations. Beyond its research work the I2 group has developed a comprehensive tutorial "Semantic Web Policies: where are we and what is still missing". The tutorial has been given at ESWC 2006 and a revised version at RuleML 2006.

The controlled natural language thread of I2 has further extended the language ACE (Attempto Controlled English), a controlled natural language for knowledge representation, specifically for the Semantic Web. In August 2006 ACE 5 has been released with signifi-

cant language extensions like modality, sentence subordination and negation as failure. Furthermore, a bidirectional mapping between ACE and OWL DL has been defined. That means ACE can be translated into OWL DL and OWL DL can – to some extent – be verbalized in ACE. Furthermore, in cooperation with the group A2 on Bioinformatics ACE has been used as an ontology language for protein interactions. Version 5 of ACE and its associated tools and example applications have been prototypically implemented and are available online at http://www.ifi.unizh.ch/attempto/.

In the next months the group I2 will work on technical specifications of Protune, for example, specification of the negotiation protocol and of the interface between Protune and legacy software. In its controlled language thread I2 will work on further ACE language extensions and the prototypes of the associated extended tools. In particular, the group works on *ACERules*, a powerful implementation of prioritised rules expressed in ACE.

Composition and Typing (I3). The future Semantic Web will only be successful if applications can be produced very quickly. To this end, an appropriate reuse technology should be developed that treats many different ontologies, and also different ontology languages. For reuse, type systems and component models play a major role. Type systems provide reuse from the programming languages point of view; component models provide reuse from the application point of view. Interesting application fields are Web shops for companies from *different* application domains that are individually tailored yet based on re-usable inter-operable components.

The I3 group works in the two fields composition and typing. The group is creating a composition framework for the joint use of different rule and ontology languages. The main challenges are to integrate different rule/ontology components and thus to enhance inter-operability. Reusability of the components will allow users to develop new Semantic Web applications much more quickly. Furthermore, type systems for REWERSE Web reasoning language are developed.

In 2006, the I3 group has developed a typing system for the query and transformation language Xcerpt (as developed by the group I4), which can help to find errors in query programs. Furthermore, the group I3 is investigating how the typing can provide valuable optimization strategies for the Xcerpt engine itself. For composition, the group has developed an invasive composition framework that targets languages developed within REWERSE and in the larger Web community, e.g. Xcerpt and OWL. The framework is flexible to easily allow new composition ideas to be prototyped and experimented with to find the future techniques needed for the Semantic Web. Examples of prototyped techniques include a module system for Xcerpt and the reuse of modelling decisions in OWL.

For both research activities, composition and tpying, I3 has developed prototypes that are available online on http://rewerse.net/I3/. In particular, in December the group has released the *Reuseware Composition Framework* toolset on sourgefourge.net. Reuseware is a language independent composition framework to quickly develop composition environments for programming, ontology, query, modeling and other formal languages. The work is specifically aimed towards languages in the context of the Semantic Web, such as OWL, Xcerpt, Xquery etc, but is not limited to them.

In the next months the groups will work on supporting collaborating working groups within REWERSE with its composition and typing technology. Developed typing tools will be integrated into selected REWERSE tools and applications, in particular into the Xcerpt prototype. Vice versa, I3 will use languages of other REWERSE working groups, e.g. I1's visual rule-based ontology language URML to refine I3's composition ontology.

Reasoning Aware Querying (I4). Querying, that is, the efficient and effective access to data, is one of the most essential enabling technologies for any information system. This also holds for the Web. In the Web context, *reasoning capabilities* enhance traditional search and access technologies to be able to cope with heterogeneous, incomplete, and often even inconsistent information.

Existing Semantic Web query languages lack a *general* support for querying and reasoning. Therefore, the goal of I4 is to develop a Web query and transformation language that enables more "meaningful" access to Web and Semantic Web data by integrating reasoning capabilities into the language. The technology is for example useful where a "traditional" Web search produces many results that need human interpretation, while using a query language that has flexible query and reasoning facilities would allow to automate the "filtering" from large selections of data (such as those returned from a traditional search engine).

As a core activity, the group I4 is developing the versatile rule-based Web query language Xcerpt (http://xcerpt.org). Xcerpt has three major features: integrated access to both, standard Web data (in XML) and upcoming Semantic Web information (in RDF, Topic Maps, or OWL), powerful but easy-to-use reasoning capabilities and easy extensibility for new Web technologies. Xcerpt uses a rule-based, pattern-based, "query-by-example" style to access data in different representation formats. A prototype implementation of both Xcerpt and a user-friendly visualisation visXcerpt are available.

In 2006 the group I4 has provided a declarative Semantics and Query Core for the Xcerpt Query Language. This supports on the one hand verifying the correctness and completeness of language implementations, on the other hand servers as a formal specification for users who want to understand and use the language.

Furthermore, the group has continued working on AmaXos, an efficient framework for Xcerpt processing using an Abstract machine. The group has also worked on using technology from other REWERSE working groups to be integrated into the upcoming Xcerpt processor, e.g. I3's type checking and composition results.

Beyond research on Xcerpt, the group has given a revised Survey over Existing Query and Transformation Languages. This is the first systematic survey on a large number of query languages accessing data in diverging representation formalisms such as XML, RDF, Topic Maps. The survey also identifies design principles for I4's intended versatile Web query language

In the upcoming months the group continues working on the prototypical implementation of a core language processor for Xcerpt. The implementation will be tested on a number of Semantic Web applications. Also the group works on defining the core language syntax of REWERSE at a pre-standard level.

In a different thread, I4 members in Vienna are working on *dlvhex*, a prototype application for computing the models of so-called HEX-programs, which are an extension of Answer-Set Programs towards integration of external computation sources (cf. http://con.fusion.at/dlvhex/). The goal is to extend the Ontology Layer of the Semantic Web with rules in order to have powerful and sophisticated inference mechanisms on top of ontologies. Answer Set Programming (ASP) has been introduced to the Semantic Web development because it offers the benefits of a fully declarative, nonmonotonic logic programming semantics. The first official version of dlvhex has been completed in May 2006. In addition, a number of extensions have been added, for example, an interface to the WordNet database in order to enable linguistic reasoning. A paper of the group about

the implementation of dlvhex, the reasoner for HEX-programs, has received the Best Paper Award at ESWC 2006. The group currently works on developing an interface from dlvhex to Xcerpt.

Evolution and Reactivity (I5). The Semantic Web can be seen as a "living organism", combining evolving data sources and knowledge repositories. This dynamic character of the Semantic Web requires languages and mechanisms for specifying its maintenance and evolution. Moreover, the Semantic Web resources may need to be reactive, not only to incorporate and propagate updates (e.g. a new flight schedule), but also in that they should perceive events (e.g. a flight cancellation) and incoming messages, communicate with other components (informing the business partner) and execute actions (e.g. booking an alternate flight). Dealing with evolution and reactivity on the Web requires reasoning based on rules.

Working group I5 therefore works towards the definition of declarative rule-based languages, methodologies and tools for specifying evolution and reactivity in the Web and in the Semantic Web. Evolution and Reactivity play an important role for upcoming Web systems such as online marketplaces, scientific workflows, adaptive Web and Semantic Web systems, as well as Web Services and Grids.

In 2006 the group I5 has continued working on two approaches and prototypes: the language XChange and the general ECE framework. The language XChange is a declarative high-level language for programming reactive behaviour, evolution, and distributed applications on the Web. XChange embeds the facilities of Xcerpt, the query language developed by the REWERSE group I4. In 2006 the group has particularly worked on supporting composite event detection. A prototype of XChange is available and has been demonstrated at several occasions, for example, at the Semantics 2006.

Since the Semantic Web is heterogeneous it is not only important to have a concrete language for dealing with evolution and reactivity, but also to have more general frameworks within Semantic Web applications. These frameworks are ideally modular, and the *concepts* and the actual *languages* are independent. The group I5 has proposed such a general framework that is based on general Event-Condition-Action (ECA) rules. The framework deals with language heterogeneity at the rule component level for realizing reactive behaviour on the Web. For the general framework the r3 (Resourceful Reactive Rules) prototype has been developed. The prototype r3 provides a Semantic Web rule engine for reactive rules. Reactive rules are understood as RDF-resources, and the different components of each reactive rule may be specified (or even composed) using different languages. Together with the demonstrator r3 several (sub)engines for component languages are provided. r3 can not only process rules formalized in ECA-ML, an XML ECA rule (markup) language, but it provides, in particular, engines for XChange/Xcerpt, which makes it possible to fully integrate XChange with the general framework (making it possible e.g. to use Xcerpt for querying data in the condition part of rules, or to use XChange for updating XML data in the action part of a rule). Another engine is provided for the language Prova that is being developed within REWERSE by the group A3 in Dresden. Notably, parts of the r3 prototype were implemented in Prova, thus taking advantage of the collaboration in REWERSE.

In the coming months the group will work on defining a concrete ontology for Reactive Rules at the RDF/OWL level, in line with the general framework, also taking into consideration requirements from other REWERSE groups. Furthermore the group will test and refine its prototypes, and their usage in several use case scenarios.

Work Area: Reasoning for Advanced Web Applications

REWERSE integrates three working groups on Web applications focusing on adaptive Web systems and Web-based decision support systems. The applications function as test-beds for the reasoning languages developed in the research oriented working groups.

Event and Location (A1). Almost all developments in the Semantic Web area –XML, RDF, query languages, rule languages, ontology mechanisms, etc. – are frameworks with very little built-in support for non-trivial concrete datatypes and theories. The frameworks would become much stronger and much more user-friendly if frequently used concepts could be directly integrated.

The working group A1 on "Event and Location" works on Web-based decision support for event, temporal and geographical data. More concretely, the group develops theories for "geotemporal" notions (*next Christmas*), "geospatial" notions (*closest pharmacy*), and for topics (*music event*) ready for the integration into, for example, query languages or ontology mechanisms. A use-scenario is for example if a user queries a Web based XML database about cinemas and movies in Munich e.g. with "Which cinema in the eastern part of Munich plays a movie about a sports event this weekend?" This query combines temporal (*this weekend*), spatial (*eastern part of Munich*) and topical (*sport event*) information. Reasoning is required to match "eastern part of Munich" for example with addresses in a database (geospatial reasoning), "this weekend" to a personal specification of "weekend" (geotemporal reasoning), and it must understand the topic "sports event". The primary goal of the group A1 is to provide the theoretical and implementational basis for the integration of this kind of reasoning into the REWERSE query languages. The main challenges concern first the development of precise and versatile theories, and then the integration into XML query languages, ontology specification systems and logic based inference systems.

In 2006 the group has continued working on the temporal specification language GeTS (GeoTemporal Specification Language), a functional language for specifying temporal notions, and it has provided the first prototype of its spatial counterpart, the language MPLL (multiparadigm locational language). With the two languages the group provides very flexible and powerful mechanisms to integrate temporal and spatial reasoning into different host languages and applications. Concurrently, several peripheral systems and applications have been developed, such as the Local-Data-Stream Management System (L-DSMS) for processing streams of (XML) data, an ontology driven visualisation system based on OWL and SVG, and a flexible network routing applications (TransRoute). Furthermore, the group has worked on one of the applications of geospatial world models and geospatial information processing, viz., guiding persons through indoor environments where the route description is given via automatically generated natural language navigation commands.

The group currently focuses on the integration of these different components and data sources.

Bioinformatics Semantic Web (A2). With the explosion of online accessible bioinformatics data and tools, systems and data integration has become very important for further progress. Currently, bioinformatics relies heavily on the Web. But the Web is geared towards human interaction rather than automated processing. The REWERSE group A2

on “Bioinformatics Semantic Web” works on using rules and reasoning for annotating and extracting biological data automatically thus supporting biomedical researchers.

Imagine a scientist is searching for genes with certain properties that are likely to be responsible for a certain disease. To find the information from the online accessible data often requires time-consuming manual search since the data on the Web are not designed for automated use. Solving this problem and retrieving information from Web data sources automatically requires a suitable annotation of the data, the possibility to formulate complex queries and rules for the mediation of the different data sources, techniques for the consistent integration of different Bioinformatics data and – to enhance user-friendliness – adaptive portals for molecular biologists.

The goal of the REWERSE Bioinformatics Semantic Web group A2 is to demonstrate novel, reasoning-based solutions for the above requirements thus working towards a Semantic Web for the life sciences. The group deploys rules and reasoning for ontologies and text mining, gene expression data analysis, metabolic pathways, structure prediction and protein interaction. Enabling these tools on the Web sets the foundation for a *Semantic* Web for life sciences.

In 2006 the group has continued building prototype applications to demonstrate the idea of a rule-based Web for bioinformatics. Applications developed by group members comprise among others the use of constraint satisfaction for sequence alignment (BIOCHAM), reasoning over interaction networks and metabolic pathways (BioRevise), rules to consistently integrate online biological data (GoProteins), automated integration of biomedical ontologies (Sambo), and GoPubMed.org, an intelligent literature search engine. GoPubMed has led to the spin-off company Transinsight GmbH, which received seed funding by the Hightech Gründerfonds in Germany.

Furthermore, in 2006 A2 has shown how it links to REWERSE’s technology working groups I2, I4 and I5. The group has investigated how the controlled natural language Attempto developed by I2 can be used for text-mining of biomedical literature. Bioinformatics poses specific requirements to querying, as data can be large, distributed, and in varying formats. The group has studied how the query language Xcerpt developed by I4 can address these challenges. A2 and I5 collaborate on Prova, a language specifically designed for systems integration in bioinformatics.

The group plans to further work out the bioinformatics demonstrators with a specific focus on protein interaction networks. Also links to other REWERSE groups will be followed, for example, how to employ typing mechanism developed by I3 to reason over metabolic networks.

Personalized Information Systems (A3). The vision of the Semantic Web is that machines are enabled to understand the meaning of information on the Web. This idea calls for smarter applications that better support humans in carrying out their tasks. In particular, applications are interesting that can retrieve, process and present information in enhanced user-adapted ways. The Semantic Web thus calls for “Personalized Information Systems”, that is, information producing systems that can autonomously interoperate – either with humans or with other systems –, tailoring their processing and its outcome to specific requests.

The goal of the REWERSE group A3 on “Personalized Information Systems” is to optimize the access to digital information on the Web according to the needs and requirements of each end user. The work of A3 involves three action lines: theoretical foundations of personalization in the context of the Semantic Web, algorithms and implementa-

tions of personalization functionality in the Semantic Web, and – in close co-operation with other REWERSE groups – test and validate rule and reasoning languages for the purpose of personalization. The latter is particularly interesting since to realise powerful Personalized Information Systems on the Web the reasoning mechanisms investigated in REWERSE are highly relevant, in particular reasoning about policies, mechanisms for handling failure, dealing with updates and events in the Web context, etc. Possible use-scenarios of personalization on the Web are manifold. The group particularly investigates personalized search on the Web, E-learning, tourist information systems, domotic systems, health care etc. The main challenges are the *automated* extraction of *semantic* information from the Web, the efficient use and implementation of personalization rules to reason over the data, and personalization and visualization services to syndicate the results.

The A3 group has shown how reasoning enables personalization in the Semantic Web. Various prototypes and applications have been developed, among them the Semantic Web Challenge Award laureate "Personal Publication Reader". The Personal Publication Reader is part of the more general "Personal Reader Framework" (www.personal-reader.de) that A3 is developing. The idea is that when a user is viewing some Web Content (the *Reader* part of the Personal Reader) s/he receives additional, personal information on the context of this particular Web content (the *Personal* part of the Personal Reader). The core of the Personal reader is a modular framework of components / services: for providing the user interface, for mediating between user requests and available personalization services, for user modelling, for providing personal recommendations and context information, etc. Further modules of the Personal Reader Framework have been developed in 2006, in particular the "Personal Reader Agent" which enables users to select, configure and call Configurable Web Services (www.personal-reader.de/agent/). Also a personal reader for E-Learning Systems on the Web is worked on.

Current investigations of the A3 group focus on personalization strategies and algorithms, re-usability or personalization functionality, and an architecture for realizing "Personalization Services" in the Semantic Web.

Work Area: Knowledge Dissemination on Reasoning on the Web

REWERSE integrates Activities groups that aim at the dissemination of knowledge created within REWESE. Their goal is to spread excellence throughout the European region and outside of it in a way that guarantees a durable effect. REWERSE contains four activity groups: "University Education and Training", "Technology Transfer and Awareness", "Standardisation" and "Presentation, Reviewing and Assessment".

Education and Training (ET). The main objective of the group on "Education and Training" is to initiate and foster a durable education on Semantic Web issues. The group focuses on three action lines: running a yearly Summer School, developing and publishing an infrastructure for Web based Semantic Web courses, and developing Web based graduate curricula and courses for Semantic Web topics.

In 2006, the ET group has very successfully organised the second Summer School "Reasoning Web 2006" which was held on 4-8 September 2006 in Lisbon, Portugal with 65 registered participants. The objective of the Summer School Reasoning Web 2006 was to provide a coherent introduction into Semantic Web methods and issues with a particular focus on their usage in bio-health applications (cf. http://reasoningweb.org/2006/). A highly appreciated Summer School tutorial volume appeared in the Lecture Notes in

Computer Science series by Springer-Verlag as LNCS 4126. The third Reasoning Web Summer School will take place on 3-7 September 2007 in Dresden, Germany with a particular focus on reasoning.

Furthermore, the group has – in co-operation with the Knowledge Web Network of Excellence – contributed to the Web repository REASE, a repository of the European Association for Semantic Web Education (EASE) for e-learning units in the area of Semantic Web (cf. http://rease.semanticweb.org). REASE supports sharing knowledge for Higher Education as well as for industrial education in the area of Semantic Web and is open to any member of the academic or research community. ET contributed a set of graduate courses, including parts of the Reasoning Web 2006 electronic course material. Furthermore, ET contributed to the development of a Semantic Web Topic Hierarchy published on *ontoworld.org*, the wiki for the Semantic Web community (http://wiki.ontoworld.org/wiki/Semantic_Web_Topic_Hierarchy). The taxonomy gives a classification of Semantic Web related topics with short explanations.

Technology Transfer and Awareness (TTA). The goal of the "Technology Transfer and Awareness" group TTA is to increase the awareness of REWERSE's results and research topics in industry. More generally, the group also aims at increasing the awareness of Semantic Web topics in general. The activities include in particular the organisation of awareness events and promotional material targeted at industry and the general creation of a technology transfer infrastructure within REWERSE. Furthermore, the group works – in co-operation with ET – on industry education, for example, Web based courses on Semantic Web issues.

In 2006 the activity group TTA has organised several industry awareness events, for example a REWERSE stand with several demos at the Semantics 2006, 28-30 October, Vienna, Austria. In addition, the group has produced various dissemination material, for example, a banner and an updated project fact sheet. As for industry education, the group has worked on developing teaching modules and a teaching infrastructure on Semantic Web issues targeted at industry (together with the education and training group ET).

The group currently prepares the second Semantic Web Days scheduled for September 2007 in Graz, Austria. This event will be a continuation of the very successful first Semantic Web Days held in October 2005 in Munich. The Semantic Web Days provide an exchange platform for innovative companies and research institutions on industry relevant Semantic Web topics. Also, industry targeted REWERSE contributions at the European Business Rules Conference in June 2007 in Düsseldorf, Germany, are currently being prepared.

Standardisation (STD). Since November 2005 REWERSE has a dedicated standardisation activity group. The group is devoted to promoting outcomes of REWERSE's research within standardization organisations and providing feedback towards REWERSE on relevant standardisation work. To this end, the group performs an up-to-date technology watch within standardization organisations and within the REWERSE project.

REWERSE is a W3C Member since October 2005. Currently, REWERSE members are actively involved within the standardization work of the W3C Rule Interchange Format Working Group (RIF WG) and the W3C Semantic Web Health Care and Life Sciences Interest Group (HCLSIG). The W3C RIF WG aims to develop a format for rules, such that they can be interchanged between different rule languages and systems. Members of the REWERSE standardisation activity have contributed a use-case on policies for the First Public Working Draft 'RIF Use Cases and Requirements'. Furthermore, the STD

co-ordinator has been an editor of the Working Draft on requirements on RIF. REWERSE has also contributed to the organisation of face-to-face meetings of the RIF working group. The W3C HCLSIG aims to improve research and development in the health care and life science industries. Further W3C standardisation activities concern a participation in W3C activity on "Languages for Privacy Policy Negotiation and Semantics-Driven Enforcement" and a possible participation in the Semantic Web Education and Outreach (SWEO) Interest Group.

Presentation, Reviewing and Assessment (PRA). The activity group "Presentation, Reviewing and Assessment" monitors all important REWERSE results and activities. The group communicates these achievements to the European Commission, to the IT professional communities and to a wide audience of interested people. In particular, the group publishes all REWERSE related publications, deliverables, demonstrators and other important information on http://rewerse.net thus creating a valuable and up-to-date research archive on topics related to Rules and Reasoning on the Web.

Furthermore, members of the PRA group have been strongly involved in the organisation and in the programme committee of the fourth Workshop on "Principles and Practice of Semantic Web Reasoning" (PPSWR 2006) that was held in Budva, Montenegro, 10-11 June 2006 (cf. http://rewerse.net/PPSWR06/). PPSWR 2006 has been co-located with the European Semantic Web Conference (ESWC) as a major Semantic Web event. Proceedings have been published by Springer LNCS as volume 4187. The PPSWR workshop series provides a forum for discussing various forms of reasoning that are or can be used on the Semantic Web. The workshop addressed both, reasoning methods for the Semantic Web and Semantic Web applications relying upon various forms of reasoning. Starting in June 2007 the PPSWR workshop series will be merged into a new and larger conference series, viz. The International Conference on Web Reasoning and Rule Systems (RR). (cf. http://www.wrrs.info/).

In the next month the PRA group plans to collect and co-ordinate the production of demonstration materials from the various REWERSE working groups with a particular focus on the demonstration material for the prototypes.

User Involvement, Promotion and Awareness

Main Contacts and Co-operations

FP6 projects

- Knowledge Web (http://knowledgeweb.semanticweb.org/)
- KnowledgeBoard 2.0 (http://www.knowledgeboard.com/)
- MUSING (http://www.musing-project.eu/)

Others

- DERI, Innsbruck (www.deri.at)
- RuleML Initiative (www.ruleml.org)
- Salzburg Research(www.salzburgresearch.at/)
- Semantic Web School Vienna (www.semantic-web.at)

- W3C (www.w3c.org)
- Various companies: Elsevier, HP labs, ILOG, Jentro, ontoprise, Resprotect, SAP, Scionics, Siemens, Transinsight, Unilever

Main Promotion and Awareness Events

Main Events

Summer School Reasoning Web 2006

4-8 September 2006
Lisbon, Portugal
http://reasoningweb.org/2006/

Workshop PPSWR 2006 ("Principles and Practice of Semantic Web Reasoning")

10-11 June 2006
Budva, Montenegro
http://rewerse.net/PPSWR06/

PPSWR 2006

REWERSE Exhibition at Semantics 2006

28-30 November 2006
Vienna, Austria
http://www.semantics2006.net/

reasoning
semantics web

SEMANTICS 2006

Stands, Tutorials

"Personal Publication Reader" participates in CeBIT 2006 exhibition

9-15 March 2006
Hannover, Germany
http://www.semantics2006.net/

PERSONAL READER

CeBIT HANNOVER 9.–15. 3. 2006

Tutorial "Rich Clients need Rich Interfaces: Web-Anfragesprachen für XML und RDF" at XML Tage Berlin, 2006

25-27 September 2006
Berlin, Germany
http://www.berliner-xmltage.de

>xcerpt>

XML Clearinghouse

Tutorials on"Semantic Web Policies" at ESWC'06 and RuleML'06

11 June, 2006, Budva, Montenegro
10 November 2006, Athens, Georgia
http://cs.na.infn.it/rewerse/events.html

Workshops co-organised by REWERSE Working Groups

Semantic Web Policy Workshop (SWPW'06), at ISWC 2006
http://www.l3s.de/~olmedilla/events/2006/SWPW06/ (WG I2)

Workshop on Models of Trust on the Web (MTW'06), at WWW 2006
http://www.l3s.de/~olmedilla/events/MTW06_Workshop.html (WG I2)

W3C Workshop on Languages for Privacy Policy Negotiation and Semantics-Driven Enforcement
http://www.w3.org/2006/07/privacy-ws/ (WG I2)

Workshop Reactivity on the Web' at EDBT 2006
http://www.pms.ifi.lmu.de/webreactivity/2006/ (WG I5)

Semantic Web Personalization Workshop (SWP06) at ESWC 2006
http://www.kbs.uni-hannover.de/~henze/swp06/ (WG A3)

Other Promotion Activities

The group I1 has initiated a blog on rules on the Web.

RealRules Blogzine (http://www.realrules.info/)

RealRules provides educational material, insider information and news about all aspects of all kinds of rules: rule languages, rule engines, business rules management, rule-based systems, and more.

Spin-off Company

The intelligent literature search engine GoPubMed.org, developed by the REWERSE working group A3 on Bioinformatics, has lead to the spin-off Transinsight GmbH, which received seed funding by the Hightech Gründerfonds in Germany.

Transinsight develops intelligent search technologies for the life sciences.

Transinsight is an award-winning start-up company providing products and solutions for intelligent search technologies in the life sciences.

gopubmed

The search engine GoPubMed reduces search time and increases the relevance of search results significantly. GoPubMed uses a generic technology which can be adopted to other domains like medicine and the food industry.

Project-level involvement

Publications. At month 32 REWERSE members have contributed to over 370 internationally reviewed publications showing that REWERSE's focus is perfectly targeted to current research needs (cf. http://rewerse.net/publications.html).

Standardisation. REWERSE holds a W3C Consortium membership since October 2005 granting REWERSE members access to W3C working groups. REWERSE's standardisation activities include the establishment of a standardisation co-ordinator and a standardisation task force. REWERSE actively participates in several W3C activities, in particular

- Rule Interchange Working Group (http://www.w3.org/2005/rules/wg.html)
- Semantic Web Health Care and Life Sciences Interest Group (http://www.w3.org/2001/sw/hcls/)

Meetings. Several project meetings and inter-WP collaboration workshops have intensified the co-operation within REWERSE and beyond.

Future Work

In its final year REWERSE will put its demonstrators into full function. The demonstrators will be made publicly available, mostly as open source projects. Integration of prototype components of different working groups will be prototypically implemented. Demonstration material showing the main features of the prototypes and the research results will be produced. This demonstration material prepares intensified promotion of REWERSE's demonstrators and languages to the industry and to the interested public.

The languages and methodologies developed within REWERSE will be consolidated, this includes the final specification and the definition of the main principles. The goal is to formulate pre-standards that can be input to standardisation organisations. REWERSE will continue its standardisation work within the W3C. In particular, contributions to the RIF working group will be continued.

In 2007, there will be two larger technology transfer events, the second Semantic Web Days in September 2007 and a REWERSE event with talks at the European Business Rules Conference in June 2007. Furthermore, the Technology Transfer group will provide a list of industrial training modules.

The Education and Training group will organize the third Summer School on Reasoning Web that will take place in September 2007 in Dresden. The group will also continue its work on the higher education curriculum and a final educational infrastructure will be defined.

As for research dissemination, in 2007 REWERSE will co-organize the First International Conference on Web Reasoning and Rule Systems (RR 2007) that will take place on 7-8 June 2007 in Innsbruck (Austria) (cf. http://www.wrrs.info/). The new conference RR aims to be the major forum for discussion and dissemination of new results on all topics concerning Web Reasoning and Rule Systems. RR brings together three previously separate events: the International Workshop on Principles and Practice of Semantic Web Reasoning (PPSWR), the International Conference on Rules and Rule Markup Languages for the Semantic Web (RuleML), and the International Workshop on Reasoning on the Web (RoW).

Finally, in its final year REWERE will initiate activities that last beyond the formal end of REWERSE. It is planned to continue the Reasoning Web Summer School and the RR conference. Furthermore, it is planned to keep a formal networking structure to foster rules and reasoning on the Web. Also continued participation in the W3C is envisaged.

Further Information

Information on the Web

REWERSE Web Site	http://rewerse.net
Working Groups	http://rewerse.net/workinggroups.html
Activity Groups	http://rewerse.net/activities.html
Participants	http://rewerse.net/participants/index.html
Publications and Deliverables	http://rewerse.net/publications.html
Demos and Presentations	http://rewerse.net/downloads_demos/
Contact	http://rewerse.net/contact.html Co-ordinator: Prof. François Bry Manager: Dr. Uta Schwertel Institute for Informatics University of Munich Oettingenstr. 67 D-80538 Munich, Germany

Project Facts in Brief

Project Acronym	REWERSE
Project Reference	506779
Framework	FP6
Priority	Priority 2, IST
Action Line	Semantic-based knowledge systems
Contract Type	*Network of Excellence*
Start Date	2004-03-01
Duration	48 months
Project Funding	5 150 000 € (European Commission), 360 720 € (Switzerland)27
Participants	from 14 European countries
Website	http://rewerse.net