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D3.2.4 Joint curriculum for a shared masters program

Enrico Franconi (Free University Bolzano)
Asunción Gómez Pérez (Universidad Politécnica de Madrid)
Frank van Harmelen (Vrije Universiteit Amsterdam)
Marco Roncetti (Universitá di Trento)
Mari Carmen Suárez de Figueroa (Universidad Politécnica de Madrid)
York Sure (University of Karlsruhe)
Holger Wache (Vrije Universiteit Amsterdam)

Abstract.
EU-IST Network of Excellence (NoE) IST-2004-507482 KWEB
Deliverable D3.2.4 (WP3.2)
This deliverable contains the curriculum for the European Academy for Semantic web Education (EASE), the shared master program which trains master students to high qualified Semantic Web experts.
Keyword list: curriculum, European Academy for Semantic web Education

Document Identifier	KWEB/2005/D3.2.4/v1.0
Project	KWEB EU-IST-2004-507482
Version	v1.0
Date	January 28th, 2006
State	final
Distribution	public

Knowledge Web Consortium

This document is part of a research project funded by the IST Programme of the Commission of the European Communities as project number IST-2004-507482.

University of Innsbruck (UIBK) - Coordinator
Institute of Computer Science
Technikerstrasse 13
A-6020 Innsbruck
Austria
Contact person: Dieter Fensel
E-mail address: dieter.fensel@uibk.ac.at

École Polytechnique Fédérale de Lausanne (EPFL)
Computer Science Department
Swiss Federal Institute of Technology
IN (Ecublens), CH-1015 Lausanne
Switzerland
Contact person: Boi Faltings
E-mail address: boi.faltings@epfl.ch

France Telecom (FT)
4 Rue du Clos Courtel
35512 Cesson Sévigné
France. PO Box 91226
Contact person : Alain Leger
E-mail address: alain.leger@rd.francetelecom.com

Freie Universität Berlin (FU Berlin)
Takustrasse 9
14195 Berlin
Germany
Contact person: Robert Tolksdorf
E-mail address: tolk@inf.fu-berlin.de

Free University of Bozen-Bolzano (FUB)
Piazza Domenicani 3
39100 Bolzano
Italy
Contact person: Enrico Franconi
E-mail address: franconi@inf.unibz.it

Institut National de Recherche en Informatique et en Automatique (INRIA)
ZIRST - 655 avenue de l'Europe -
Montbonnot Saint Martin
38334 Saint-Ismier
France
Contact person: Jérôme Euzenat
E-mail address: Jerome.Euzenat@inrialpes.fr

Centre for Research and Technology Hellas / Informatics and Telematics Institute (ITI-CERTH)
1st km Thermi - Panorama road
57001 Thermi-Thessaloniki
Greece. Po Box 361
Contact person: Michael G. Strintzis
E-mail address: strintzi@iti.gr

Learning Lab Lower Saxony (L3S)
Expo Plaza 1
30539 Hannover
Germany
Contact person: Wolfgang Nejdl
E-mail address: nejdl@learninglab.de

National University of Ireland Galway (NUIG)
National University of Ireland
Science and Technology Building
University Road
Galway
Ireland
Contact person: Christoph Bussler
E-mail address: chris.bussler@deri.ie

The Open University (OU)
Knowledge Media Institute
The Open University
Milton Keynes, MK7 6AA
United Kingdom
Contact person: Enrico Motta
E-mail address: e.motta@open.ac.uk

Universidad Politécnica de Madrid (UPM)
Campus de Montegancedo sn
28660 Boadilla del Monte
Spain
Contact person: Asunción Gómez Pérez
E-mail address: asun@fi.upm.es

University of Karlsruhe (UKARL)
Institut für Angewandte Informatik und Formale Beschreibungsverfahren - AIFB
Universität Karlsruhe
D-76128 Karlsruhe
Germany
Contact person: Rudi Studer
E-mail address: studer@aifb.uni-karlsruhe.de

University of Liverpool (UniLiv)
Chadwick Building, Peach Street
L697ZF Liverpool
United Kingdom
Contact person: Michael Wooldridge
E-mail address: M.J.Wooldridge@csc.liv.ac.uk

University of Manchester (UoM)
Room 2.32. Kilburn Building, Department of Computer Science, University of Manchester, Oxford Road
Manchester, M13 9PL
United Kingdom
Contact person: Carole Goble
E-mail address: carole@cs.man.ac.uk

University of Sheffield (USFD)
Regent Court, 211 Portobello street
S14DP Sheffield
United Kingdom
Contact person: Hamish Cunningham
E-mail address: hamish@dcs.shef.ac.uk

University of Trento (UniTn)
Via Sommarive 14
38050 Trento
Italy
Contact person: Fausto Giunchiglia
E-mail address: fausto@dit.unitn.it

Vrije Universiteit Amsterdam (VUA)
De Boelelaan 1081a
1081HV. Amsterdam
The Netherlands
Contact person: Frank van Harmelen
E-mail address: Frank.van.Harmelen@cs.vu.nl

Vrije Universiteit Brussel (VUB)
Pleinlaan 2, Building G10
1050 Brussels
Belgium
Contact person: Robert Meersman
E-mail address: robert.meersman@vub.ac.be

Work package participants

The following partners have taken an active part in the work leading to the elaboration of this document, even if they might not have directly contributed to writing parts of this document:

Free University of Bozen-Bolzano
Universidad Politécnica de Madrid
University of Karlsruhe
University of Trento
Vrije Universiteit Amsterdam

Executive Summary

The Semantic Web and its technology are increasingly becoming a central element of many activities in computer science. More and more people are interested and would like to enhance their skills thereon.

This demand leads to the idea of introducing a joint master's program on the Semantic Web, the , the "European Academy for Semantic web Education" (EASE). This program shall attract people with a bachelor's degree from computer science, artificial intelligence, or related areas. It is split among leading European universities, all known for excellence in the field of Semantic Web. They are currently already cooperating in the network of excellence "Knowledge Web" of the European Union. Within the two-year program prospective students will study up-to-date developments in the Semantic Web area. Courses will cover web infrastructure, Semantic Web technologies, the formal foundations of knowledge representation, information and knowledge systems, and advanced modules.

Goal of the program is to build a new generation of Semantic Web experts – and upskill the European workforce with ideas that point to the future.

In this deliverable we report on the work towards such a shared master program. We elaborate on the work towards a joint Semantic Web curriculum and show how currently existing courses offered by participating partners from Knowledge Web fit into the curriculum.

Contents

Chapter 1

Introduction

by UKARL/VU

The Semantic Web and its technology are increasingly becoming a central element of many activities in computer science. More and more people are interested and would like to enhance their skills thereon.

This demand leads to the idea of introducing a joint master's program on the Semantic Web. This program shall attract people with a bachelor's degree from computer science, artificial intelligence, or related areas. It is split among leading European universities, all known for excellence in the field of Semantic Web. They are currently already cooperating in the network of excellence "Knowledge Web" of the European Union. Within the two-year program prospective students will study up-to-date developments in the Semantic Web area. Courses will cover web infrastructure, Semantic Web technologies, the formal foundations of knowledge representation, information and knowledge systems, and advanced modules.

Goal of the program is to build a new generation of Semantic Web experts – and upskill the European workforce with ideas that point to the future.

In this deliverable we report on the work towards such a shared master program. We elaborate on the work towards a joint Semantic Web curriculum. In Section 2 we provide an overview over the curriculum which includes descriptions of the objectives of the shared master program, target groups, a structure overview and potential participants. In Section 3 we briefly introduce a Semantic Web Ontology which is used to classify courses of the shared master curriculum. We then illustrate how existing modules (sets of courses) of participating Knowledge Web partners are classified according to the ontology and provide a detailed list of basic and advanced modules of each partner. We conclude with a summary and a discussion of open issues.

Chapter 2

Overview on the curriculum

2.1 Objectives of the shared master

by UKARL

KnowledgeWeb will establish an European master program, the “European Academy for Semantic web Education” (EASE), for qualifying well–educated students for the Semantic Web. In particular the aims of this deliverable on a shared master on Semantic Web are

i. to establish a shared understanding among academic partners of what a curriculum for a Semantic Web master should contain,

ii. to make explicit the currently existing teaching courses of individual universities,

iii. to classify the courses according to an ontology about topics relevant for the Semantic Web,

iv. classify the courses according to the ECTS credit system to ensure interoperability among different universities and

v. to work towards legal agreements among participating partners to establish a shared master program.

Such a shared master program would allow students to choose courses from different universities to graduate as “Semantic Web MSc.”.

2.2 Target groups and their needs

by UKARL

The shared master program addresses students having a BSc. in Computer Science or related areas who want to specialize in their master studies in Semantic Web related topics. The shared master program should accompany other education offers from Knowledge Web such as the Knowledge Web Summer School which targets PhD students. It is foreseen that students graduating in the shared master program are on the one hand suitable candidates to follow-up PhD studies and e.g., visit later summer schools from Knowledge Web or associated partners of the network such as the REWERSE Summer School. On the other hand they have sufficient knowledge to work in companies, e.g., realizing Semantic Web applications.

2.3 Structure Overview

by VU

For the "European Academy for Semantic web Education" (EASE) a single coherent structure is prescribed. It is based on

- common and compulsory foundational modules comprising 36 ECTS credit points at minimum, which are taught at each partner institution,
- selected advanced modules comprising at minimum 36 ECTS credit points, which are based on the specific strengths in research and teaching of the partner institutions. Thus, they can vary from partner to partner,
- a research master thesis project with a minimum of 36 ECTS credit points.

Figure 2.1 shows an overview on EASE. Courses are distributed over three semesters. They amount to a total minimum of 72 ECTS credit points. In addition a minimum 36 ECTS credit points are assigned to the master's thesis and its defense in the fourth semester. The minimum figures gives some indication how much effort should be spent by students in the different modules and provides the necessary flexibility which each partner needs to implement EASE. But EASE still results in a 2-year program of 120 ECTS credit points which is guaranteed by each partner.

The basic modules are offered in the first year by all partner institutions with the common aim of bringing the students to an equivalent level of skills and knowledge. In EASE five basic modules are defined: *Catch-up*, *Web Infrastructure*, *Basic Semantic Web Technologies*, *Formal Foundations of Knowledge Representation*, and *Information and Knowledge Systems*. Courses in the Catch-up module are mainly to fresh up the knowledge of the student with material which are the base for EASE. These include logics, databases, and artificial intelligence. Furthermore especially designed bridging courses integrated

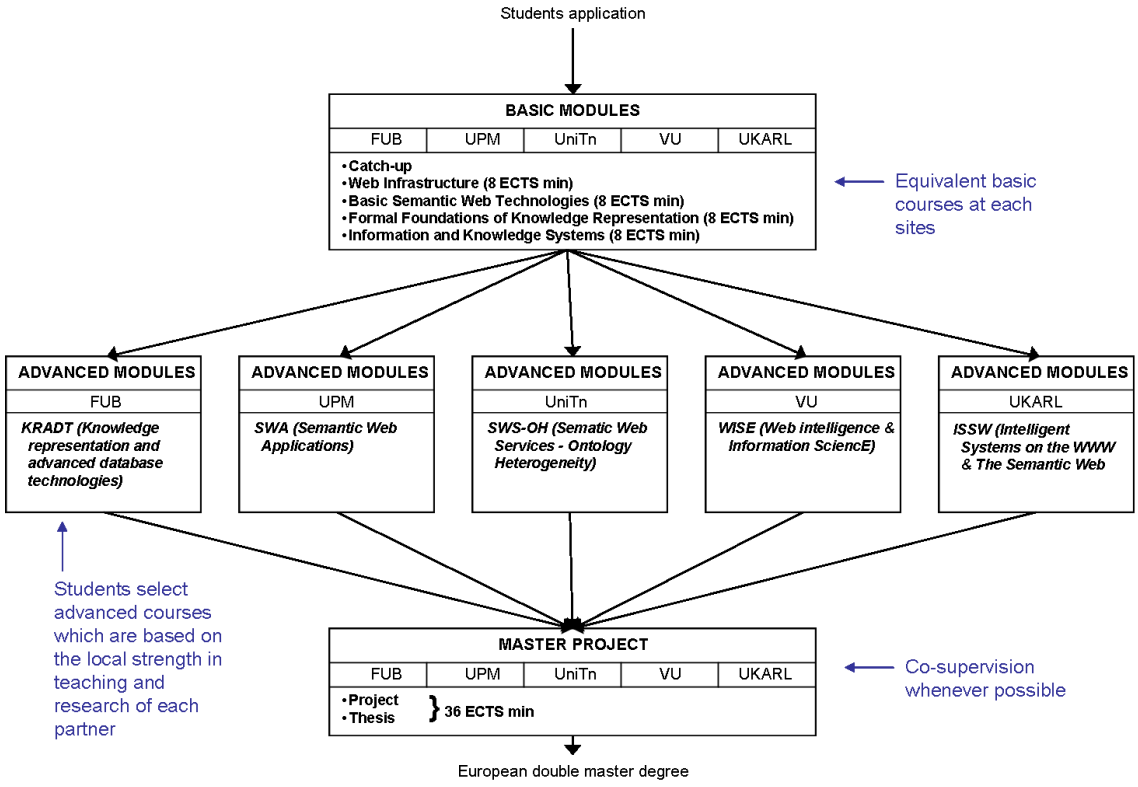

Figure 2.1: Overview of the EASE structure

into the basic modules offered in the first semester shall help 3rd country students and students from other but related professions in their adaptation to a Masters Course of European educational level.[1] The courses in the Catch-up module ensure that the next courses can build upon the same knowledge for all students.

The basic representation languages for the Semantic Web are covered by the courses in the Basic Semantic Web Technologies. Obviously this includes the introduction into XML, RDF, RDFS, and OWL. For the courses in this (and the following) modules a minimum of 8 ECTS credit points is required.[2]

All representation languages in the Basic Semantic Web Technologies module base on formal knowledge representation. A deep understanding of the underlying logics is essential for these representation languages and communicated in the courses of the Formal Foundations of Knowledge Representation module (8 ECTS min). Courses in this module cover the basic knowledge on logic, formal methods, knowledge representation and reasoning, and theory of computing.

The next two modules complete the basic modules with topics strongly related to the Semantic Web. The Web Infrastructure module (8 ECTS min) cover the basic knowledge on distributed systems, network technologies, Internet technologies, mobile services, and security, i.e. knowledge about the basic infrastructure for the Semantic Web.

The last module, Information and Knowledge Systems (8 ECTS min), focuses on the more classical approaches for information retrieval. Courses in this module may cover the basic knowledge on knowledge management, information systems, advanced database technologies, and semi-structured data.

Each partner is allowed to implement these basic modules site-specific. Courses are not prescribed and may differ from site to site; i.e. EASE does not stipulate the courses. But the five modules specify the minimal agreement and teaching material which must be covered by the basic modules. The courses associated to one module must commit to a minimal educational material in that modules. Furthermore the courses in one module must at least include 8 ECTS credit points.

Ours conjoins specialization with expertise in core Computer Science knowledge is not available at undergraduate level yet. The student's specialization (advanced modules and master project) during the second year can also be pursued with all partner institutions, but varies from place to place according to local strengths in teaching and research. It is the central idea of the shared master that the student chooses the advanced module of that EASE partner university which corresponds to his interests — with the consequence to move to that university. It should be obvious the EASE partner university for

[1] Perhaps additional courses must be taken by these students in order to reach the starting requirements of EASE.

[2] Catch-up has no minimal ECTS credit points in order to be flexible with respect to the basic knowledge of the students from each institution.

the advance module has to be different from the EASE partner university for the basic modules.

In particular the following emphases of the EASE partners are

- Knowledge representation and advanced database technologies (KRADT) [FUB]
  FUB is a leading research and teaching center on knowledge representation and advanced database technologies. Topics of study are focused in particular on formalisms for solving several problems concerning Conceptual Data Modelling and Ontology Design, Intelligent Information Access and Query processing, Information Integration, Peer to Peer systems, Semistructured Data, Distributed and Web Information Systems, Computational Logic, and Logic-based Computational Linguistics.

- Intelligent Systems on the WWW & The Semantic Web (ISSW) [UKARL]
  UKARL puts an emphasize on developing applications with Semantic Web technologies. This includes engineering and maintaining of ontologies along a well-defined life-cycle as well as deploying such applications in business scenarios. A typical application scenario is knowledge management where Semantic Web technology supports among other things knowledge sharing and reuse.

- Semantic Web Applications (SWA) [UPM][3]
  UPM is focused on developing Semantic Web applications (such as natural language processing, e-commerce, etc.). At this moment, UPM puts also efforts in the Semantic Grid area.

- Semantic Web Services - Ontology Heterogeneity (SWS-OH) [UniTn][4]
  It will be possible for students to take an advanced module concerning mainly Semantic Web Services and Ontology Heterogeneity.

- Web intelligence & Information SciencE (WISE) [VU]
  The intelligent Semantic Web techniques from the basic courses are applied in practical situations. This includes ontology engineering and innovative Semantic Web applications where amongst others a small but real Semantic Web application will be implemented. Furthermore the Semantic Web basics are extended by related techniques like distributed reasoning (e.g. with multi-agent systems) which support the nature of Web and Semantic Web.

In the final master's thesis the candidate should demonstrate his capability to solve independently a problem in the area of Semantic Web.

[3] At this moment, at UPM it is impossible to indicate precisely the courses that will be offered, because they are being presently decided.

[4] At the Universitá di Trento a rearrangement of the courses is planned for the academic year 2006-2007. In this rearrangement, a new set of courses will be offered that will focus on Web Technologies, with a strong emphasis on the Semantic Web. At present it is impossible to indicate precisely the courses that will be offered, as they are being presently decided.

The distribution of the modules and courses (basic and advanced) over individual semesters and partner institutions is listed in detail in Section 3.3. The goals of the individual modules, their prerequisites and the dependencies between modules are also given.

The general structure of this study program is not invented from scratch but we adopted the structure of the established "Shared master Program for Computer Linguistics". Good experiences with that study program motivated us to adopt their structure.

However, EASE is an open study program in general. In order to provide the required flexibility for a shared master program new partners can join EASE. Openness also implies that modules can be outsourced. For example, if another university offers a particularly strong program in Semantic Web, then it may offer a module in this area which could then be accepted in our masters program. In other words, the conceived structure allows for sufficient flexibility such that

the best students will study with the best experts in Semantic Web.

2.4 Participants

by VU

Currently EASE will be set up with the following KWEB members:

- FUB, Free University Bolzano
- UPM, Universidad Politécnica de Madrid
- UniTn, Universitá di Trento
- VU, Vrije Universiteit Amsterdam
- UKarl, University of Karlsruhe

All partner institutions mentioned in this proposal intend to participate in the integrated study program "European Academy for Semantic web Education".

The University of Karlsruhe, Universidad Politécnica de Madrid and Universitá di Trento are currently in the process of designing and implementing various master programs. At the present moment they are not able to specify their modules and courses definitely. However, their participation in the shared master program is foreseen in near future (i.e. end of 2006). For this reason their potential modules and courses are included in this curriculum and may be subject to changes in future.

A particular aspect of our "European Academy for Semantic web Education" is its scalability: Any other teaching institution (whether European or not) which has a research

and teaching staff, large and competent enough to run our program with the obvious adaptations of the second year to local strengths in research can participate in this distributed two-year Masters Course. The requirement is that the teaching institute make a successful application to EASE.

Please note, that especially the teaching participants in the European Network of Excellence REWERSE are warmly invited to join the “European Academy for Semantic web Education”.

Chapter 3

Courses for the curriculum

3.1 Towards a Semantic Web Ontology

The Semantic Web Topic hierarchy was developed jointly with REWERSE starting from the initial curriculum as discussed in the REWERSE deliverable E-D5, which itself is based upon the ACM Computing Classification System, and extends it with topics, which were not existent or relevant at the time of its creation. Specifically, the session titles of the two major conferences in the area of Semantic Web, the International Semantic Web Conference (ISWC) and the European Semantic Web Conference (ESWC) from past years were examined.

The structure of the hierarchy three-fold: Foundations – Semantic Web Core Topics – Semantic Web Special Topics

The full hierarchy is shown in table 3.1. A more detailed description of the hierarchy can be found in the REWERSE deliverable E-D7. The Semantic Web Topic Hierarchy reflects, of course, a compromise among the different opinions within the Semantic Web community (e.g., some consider ‘natural language processing’ as a foundational topic while others treat it as special topic).

The Semantic Web Topic Hierarchy is still in progress, but we considered it as the best possible starting point for the classification of courses for the shared master. The work we did helped finding some shortcomings of the Hierarchy. Among these we mention the fact that some topics that are clearly strongly related to the Semantic Web, like some logic flavors (i.e., description, modal, temporal logic) are absent from the Hierarchy. As it will be clear in the next sections, some of the Shared Master courses could not be indexed on the Hierarchy, since the corresponding area is not in the core of the Semantic Web. Also, a whole area (Information Systems) is formally present in the Hierarchy, but its level of detail is clearly insufficient. These problems were reported to the community that defined the Hierarchy, and will help make it better. In spite of these problems, we found it very useful to use the Semantic Web Topic Hierarchy.

1.0 Knowledge Engineering / Ontology Engineering
 1.0.1 Methodologies
 1.0.2 Ontology population / generation
 1.0.3 Maintenance and versioning (dynamics)
 1.0.4 Mapping / translation / matching / aligning (heterogeneity)
 1.0.5 Validation
 1.0.6 Interoperability / Integration
 1.0.7 Modularization and Composition
 1.0.8 Tools
1.1 Knowledge Representation and Reasoning
 1.1.1 Logics
  1.1.1.1 Predicate Logic
  1.1.1.2 Description Logics
  1.1.1.3 F-logic
  1.1.1.4 Modal Logics
  1.1.1.5 First-order Logics
 1.1.2 Logic Programming
  1.1.2.1 Horn Logic
  1.1.2.2 Datalog
  1.1.2.3 Prolog
  1.1.2.4 Hilog
 1.1.3 Reasoning
1.2 Information Management
 1.2.1 Data Modeling
  1.2.1.1 Conceptual models; ontologies, UML
  1.2.1.2 Relational data model
  1.2.1.3 Semistructured data
  1.2.1.4 Object-oriented model
 1.2.2 Database systems
1.3 Basic Web information technologies
 1.3.1 XML
  1.3.1.1 Namespaces
  1.3.1.2 Schema languages
  1.3.1.3 XML query and transformation languages
  1.3.1.4 XML programming techniques
 1.3.2 Web data integration
 1.3.3 Security
 1.3.4 Web services
 1.3.5 Personalization techniques
 1.3.6 Web data extraction
 1.3.7 Architecture of Web Information Systems

2.0 Semantic Web Infrastructure
 2.0.1 Architecture
 2.0.2 Semantic Web Services
2.1 Resource Description Framework / RDFSchema
2.2 Semantic Web Languages
 2.2.1 Query Languages
 2.2.2 Update Languages
2.3 Ontologies for the Semantic Web
 2.3.1 Ontology representation / Ontology languages / OWL
 2.3.2 Ontology Engineering
2.4 Semantic Web Rules + Logic
 2.4.1 Rule languages
 2.4.2 Rule Markup
 2.4.3 Reasoning languages
 2.4.4 Reasoning Engines
2.5 Proof in the Semantic Web
2.6 Security / trust / privacy in the Semantic Web
2.7 Semantic Web Applications
 2.7.1 Knowledge Management
 2.7.2 E-Learning
 2.7.3 Bioinformatics
 2.7.4 Multimedia
 2.7.5 ehealth
 2.7.6 ebusiness
 2.7.7 Law
 2.7.8 Engineering
 2.7.9 eGovernment
3 Semantic Web Special Topics
 3.1 Natural language processing / human language technologies
 3.2 Social impact of the Semantic Web
 3.3 Social networks and Semantic Web
 3.4 Peer-to-peer and Semantic Web
 3.5 Agents and Semantic Web
 3.6 Semantic Grid
 3.7 Outreach to industry
 3.8 Benchmarking and scalability

Table 3.1: The Semantic Web Ontology — Overview of Topics

3.2 Overview of classified courses

The following tables give an overview of the courses from the perspective of the content rather than the structure. The Semantic Web ontology introduced in the previous section 3.1 is used to classify the content of each course in the shared master. In particular for each courses a set of the topics from the ontology is chosen which are taught in that course. The following tables show which topic will be discussed in which course. In essence the tables indicate how well the topics of the ontology are covered by the courses.

Table 3.2 shows which courses cover (1.0) Knowledge and Ontology Engineering, (1.1) Knowledge Representation and Reasoning, and (1.2) Information Management. It can be seen, that logics and reasoning in the (1.1) Knowledge Representation and Reasoning part as well as (1.2) Information Management is well covered by every partner because logics play an important part in the basic modules which must be covered by all partners.[1] On the opposite (1.0) Knowledge and Ontology Engineering is is a specific research feature of UPM and VU. Courses about that topic can be found in the advanced modules of these partners.

Also the topic (1.3) Basic web technologies is well covered by the courses in this curriculum because the teaching material are part of the basic modules which has to be taught by each partner (see Table 3.3). But it also shows that UPM must offer a course in (1.3.1) XML and surrounding topics. Such a course is currently under preparation.

Section (2.0) in the Semantic Web Ontology contains more specific topics. Table 3.4 shows again that most Semantic Web topics are covered by EASE. In particular this includes (2.0) Semantic Web Infrastructure, (2.1) RDF and RDF(S), (2.2) Semantic Web Languages, and (2.3) Ontologies for the Semantic Web.

But not all topics in section (2.x) are relevant for all partners. These topics are mainly discussed in the advanced modules where each partner focusses its research and teaching strength. A good example is (2.4) Semantic Web Rules and Logic which is part of the Semantic Web course in Bolzano. Furthermore the different Semantic Web applications (i.e. section (2.7)) is not completely covered by all partners. However, each partner discuss some Semantic Web applications so that many Semantic Web application are covered by EASE in total.

Section (3) in the Semantic Web ontology, Semantic Web Special topics, contains good candidates for advanced modules. Courses which cover these topics are shown in Table 3.5. As one may expect not all topics are relevant for EASE including (3.2) Social Impact of Semantic Web and (3.3) Social Networks and Semantic Web. These topics are relatively new and need some time before they can be introduced into courses. Another interesting observation is that a significant number of partners have (3.1) Natural Language Processing / Human Language technologies, (3.4) Peer-to-Peer and Semantic

[1] Please note that UPM and UniTn are not able to state at the current moment which courses they will give due to their internal redesign of their bachelor/master program.

Topics Courses	Bolzano	Madrid	Trento	Amsterdam	Karlsruhe
1.0 Knowledge Engineering / Ontology Engineering		UPM-OSW			KA-ISW
1.0.1 Methodologies		UPM-OSW		VU-KMM, VU-OE	KA-KMA
1.0.2 Ontology population / generation				VU-KMM, VU-OE	
1.0.3 Maintenance and versioning (dynamics)				VU-OE	
1.0.4 Mapping / translation / matching / aligning (heterogeneity)		UPM-OSW			
1.0.5 Validation		UPM-OSW		VU-OE	
1.0.6 Interoperability / Integration	BZ-KBDB	UPM-OSW			
1.0.7 Modularization and Composition	BZ-KBDB			VU-OE	
1.0.8 Tools		UPM-OSW		VU-OE	
1.1 Knowledge Representation and Reasoning				VU-AI, VU-KBS	
1.1.1 Logics		UPM-Log	TN-L, TN-FM		KA-CS1
1.1.1.1 Predicate Logic	BZ-Log	UPM-Log		VU-Log	KA-CS1
1.1.1.2 Description Logics	BZ-KR, BZ-KBDB, BZ-nCLog			VU-ARAI, VU-IWA	KA-AI1
1.1.1.3 F-logic					KA-ISW
1.1.1.4 Modal Logics	BZ-nCLog			VU-Log, VU-AL	KA-IS2
1.1.1.5 First-order Logics	BZ-Log	UPM-Log		VU-Log	KA-ISW
1.1.2 Logic Programming		UPM-LP			KA-IS2
1.1.2.1 Horn Logic	BZ-Lang	UPM-LP			
1.1.2.2 Datalog	BZ-FDB				
1.1.2.3 Prolog	BZ-CompLog, BZ-Lang	UPM-LP			
1.1.2.4 Hilog					
1.1.3 Reasoning	BZ-KR, BZ-KBDB, BZ-FormMeth	UPM-LP		VU-Log, VU-ARAI, VU-AL, VU-IWA	KA-IS2
1.2 Information Management				VU-IR	KA-IKM
1.2.1 Data Modeling		UPM-DB	TN-IS	VU-IR	
1.2.1.1 Conceptual models; ontologies, UML	BZ-DB	UPM-DB, UPM-OSW		VU-OE	KA-CS1, KA-AI1
1.2.1.2 Relational data model	BZ-DB, BZ-FDB, BZ-DWDM	UPM-DB		VU-DB1	KA-AI1
1.2.1.3 Semistructured data	BZ-XML			VU-WKR	
1.2.1.4 Object-oriented model		UPM-DB		VU-DB1	KA-CS1, KA-AI1
1.2.2 Database systems	BZ-DB, BZ-DDB, BZ-Dlibrary, BZ-KBDB, BZ-TDB	UPM-DB	TN-IS	VU-DB1	KA-IKM, KA-DBS, KA-DBX

Table 3.2: Overview of courses per topics (1.0 - 1.2)

Topics Courses	Bolzano	Madrid	Trento	Amsterdam	Karlsruhe
1.3 Basic Web information technologies					
1.3.1 XML			TN-DSD		KA-ISW, KA-AI2, KA-DBX
1.3.1.1 Namespaces	BZ-XML			VU-WKR	KA-ISW, KA-AI2, KA-DBX
1.3.1.2 Schema languages	BZ-XML			VU-WKR	KA-ISW, KA-AI2, KA-DBX
1.3.1.3 XML query and transformation languages	BZ-XML			VU-WKR	KA-ISW, KA-AI2, KA-DBX
1.3.1.4 XML programming techniques	BZ-XML			VU-WKR	
1.3.2 Web data integration	BZ-Dlibrary		TN-DSD	VU-IWA	KA-KDD, KA-KDS
1.3.3 Security	BZ-Security		TN-NS		KA-AI2
1.3.4 Web services	BZ-Mobile	UPM-Distr.	TN-WL	VU-BI	KA-DIS
1.3.5 Personalization techniques					
1.3.6 Web data extraction	BZ-Dlibrary		TN-WIR	VU-IWA	KA-KDD, KA-KDS, KA-ISF
1.3.7 Architecture of Web Information Systems	BZ-Netw, BZ-Internet, BZ-DDB	UPM-Distr.	TN-DSD		KA-CNE, KA-AI2, KA-KPO

Table 3.3: Overview of courses per topics (1.3)

Web, and (3.5) Agents and Semantic Web in their programs for advanced modules.

However not all courses in EASE can be classified into the ontologies. Each partner has a number of courses which do not correspond with the topics in Ontology. Table 3.6 contains these courses. The topics of these courses are either more fundamental like courses with artificial intelligence or close to the border of the Semantic Web topics in the ontology. Even the last group are good candidates for extending section (3) Semantic Web Special Topics.

Topics Courses	Bolzano	Madrid	Trento	Amsterdam	Karlsruhe
2.0 Semantic Web Infrastructure		UPM-OSW			KA-ISW
2.0.1 Architecture	BZ-SemWeb	UPM-OSW, UPM-Distr.		VU-IWA, VU-BI	KA-ISW
2.0.2 Semantic Web Services	BZ-SemWeb	UPM-OSW	TN-WL	VU-IWA, VU-BI	
2.1 Resource Description Framework / RDF-Schema	BZ-SemWeb	UPM-OSW	TN-WL	VU-WKR	KA-ISW, KA-DIS
2.2 Semantic Web Languages	BZ-SemWeb	UPM-OSW			KA-ISW
2.2.1 Query Languages	BZ-SemWeb	UPM-OSW		VU-WKR	
2.2.2 Update Languages		UPM-OSW			
2.3 Ontologies for the Semantic Web		UPM-OSW			KA-ISW
2.3.1 Ontology representation / Ontology languages / OWL	BZ-SemWeb	UPM-OSW	TN-WL	VU-WKR	KA-ISW
2.3.2 Ontology Engineering	BZ-SemWeb	UPM-OSW		VU-KMM, VU-OE	KA-ISW
2.4 Semantic Web Rules + Logic					KA-ISW
2.4.1 Rule languages	BZ-SemWeb				KA-ISW
2.4.2 Rule Markup	BZ-SemWeb				KA-ISW
2.4.3 Reasoning languages					KA-ISW
2.4.4 Reasoning Engines		UPM-LP			KA-ISW
2.5 Proof in the Semantic Web	BZ-SemWeb				
2.6 Security / trust / privacy in the Semantic Web					
2.7 Semantic Web Applications					KA-ISW, KA-KMA
2.7.1 Knowledge Management				VU-WKR, VU-KMM	KA-IKM, KA-KMA, KA-KPO
2.7.2 E-Learning	BZ-DWDM				
2.7.3 Bioinformatics		UPM-BI			
2.7.4 Multimedia	BZ-HCI, BZ-Interf	UPM-NLP			
2.7.5 ehealth		UPM-BI			
2.7.6 ebusiness				VU-WKR	KA-ISF
2.7.7 Law					
2.7.8 Engineering					
2.7.9 eGovernment					

Table 3.4: Overview of courses per topics (2.0 - 2.7)

Topics Courses	Bolzano	Madrid	Trento	Amsterdam	Karlsruhe
3 Semantic Web Special Topics					
3.1 Natural language processing / human language technologies	BZ-CoLing, BZ-Ling, BZ-Text	UPM-NLP		VU-IR	
3.2 Social impact of the Semantic Web					
3.3 Social networks and Semantic Web					
3.4 Peer-to-peer and Semantic Web	BZ-DDB	UPM-MAS			KA-DIS
3.5 Agents and Semantic Web		UPM-MAS		VU-BD	KA-DIS, KA-AI2, KA-ISF
3.6 Semantic Grid		UPM-OSW, UPM-Grid			KA-DIS, KA-SGR
3.7 Outreach to industry					
3.8 Benchmarking and scalability					

Table 3.5: Overview of courses per topics (3.0 - 3.8)

Topics Courses	Bolzano	Madrid	Trento	Amsterdam	Karlsruhe
UNKNOWN	BZ-AI, BZ-ForLang, BZ-Theory, BZ-Stat, BZ-Algo	UPM-e-comm, UPM-WebApp	TN-RM, TN-FM, TN-MFCS, TN-AOSE, TN-DM	VU-AI, VU-DS, VU-NP, VU-KBS, VU-BD, VU-OD	KA-MCP

Table 3.6: Overview of unclassified courses

3.3 Detailed list of courses

In the following the modules and the courses are described detailed. Each module is described by specifying the main teaching content and how the courses in that module are structured. The following description of the courses gives a more detailed description of their contents together with the ECTS points.

The next five sections are concerned with the five basic modules. Because each partner has to implement these basic modules we give a common description of the modules and present then how each partner implements the module by a set of courses. The last section explain the advanced nodule of each partner. The advanced modules contain these courses which reflect the specific strength in teaching research of each partner. The students can choose to which advanced module they want to listen.

3.3.1 Basic Modules - Catch up

Description: These courses are mainly to fresh up the knowledge of the student with material which are essential for EASE. These include logics, databases, and artificial intelligence.

Courses from FUB

Course:	*Logic*
ID:	BZ-Log
Authors:	Enrico Franconi
ECTS:	4
Classification:	
Description:	The aim of the course is to provide students with an understanding of the formal foundations of classical logic languages and methodologies, an overview of the reasoning methods based on logics, and the ability to use classical logic as a tool for representation and reasoning in computer science. The role of logics in conceptual modeling for databases and software engineering is analysed at the end of the course. The syllabus includes: Agents that Reason Logically, Propositional Logic, Foundations of Propositional Logic, Deduction in Propositional Logic, First Order Logic, Foundations of First Order Logic, Using First Order Logic, Representation, Reasoning, and Logic.

Course:	*Introduction to Artificial Intelligence*
ID:	BZ-
Authors:	Sergio Tessaris
ECTS:	4
Classification:	

Description:	Students will be introduced to the key foundational and methodological issues in Artificial Intelligence (AI). The course will provide an overview of AI techniques and their application in a range of domains. The theoretical discussion of techniques and algorithms will be underpinned by practical exercises, thus providing students with an appreciation of the applicability in concrete problems of the techniques described in the course. The syllabus includes: Introduction to AI, Intelligent Agents, Problem solving and search techniques, Constraint satisfaction problems, Introduction to games, Introduction to planning.

Course:	*Formal Languages*
ID:	BZ-
Authors:	Jörg Nievergeld
ECTS:	4
Classification:	
Description:	Introduction to the hierarchy of automata and formal languages and the theory of computation. The syllabus includes: Models of computation, Finite state machines and applications, Theory of finite automata and regular languages, Context-free grammars and languages.

Course:	*Introduction to Databases*
ID:	BZ-
Authors:	Werner Nutt
ECTS:	8
Classification:	
Description:	The aim of the course is to provide students with an overview of database management system architectures and environments, an understanding of basic conceptual and logical database design and implementation techniques, and practical experience of designing and building a relational database. The syllabus includes: Overview of a Database Management System, The Entity-Relationship Data Model, Elements of the E/R Model, The Modeling of Constraints, Weak Entity Sets, The Relational Data Model, Basics of the Relational Model, From E/R Diagrams to Relational Designs, Functional Dependencies, Design of Relational Databases and Normal Forms, Relational Algebra, The Database Language SQL, Queries and sub-queries in SQL, Full-Relation Operations, Database Modifications, Defining a Relation Schema in SQL, View Definitions, DBMS Technologies.

Courses from UPM

Course:	*Formal Logic*
ID:	UPM-Log
Authors:	Ana Garcia Serrano
ECTS:	3
Classification:	1.1.1, 1.1.1.1, 1.1.1.5
Description:	This course gives an overview of the real application of some of the formal systems used in Computer Science: Predicate Logic and First Order Logic. The course is mainly focused on logic definitions, theorems, syntax and semantic.

Course:	*Logic Programming*
ID:	UPM-LP
Authors:	Manuel Hermenegildo Salinas
ECTS:	8
Classification:	1.1.2, 1.1.2.1, 1.1.2.3, 1.1.3, 2.4.4
Description:	This course is focused on the use of the logic as practical instrument to develop advanced applications. The course presents representation techniques and problem solving that use logic programming.

Course:	*Data Bases*
ID:	UPM-DB
Authors:	Ernestina Menasalvas Ruiz
ECTS:	3
Classification:	1.2.1, 1.2.1.1, 1.2.1.2, 1.2.1.4, 1.2.2
Description:	This course has as main goal the following one: the student will be able to analyze the information needs of a particular situation, and he/she will be able to carry out the process of building a relational data base (which solves the problem).

Courses from UniTn

Course:	*Network security*
ID:	PSW
Authors:	Fabio Massacci
ECTS:	6
Classification:	1.3.3
Description:	Part I: Security and Privacy: Introduction to Computer and Network Security; Availability, Authentication, Authorization, Accounting; Access Control Part II: Applied Cryptography: General Introduction (secret keys, public keys, digital signatures); One-Time-Pad; Stream Ciphers (RC4, GSM - A5/1); Block ciphers (DES, RC5, AES); Asymmetric Algorithms (Diffie-Hellman, RSA); Hash functions (SHA-1, MD-5); Digital Watermarking (DVD) Part III: Security Protocols: Autentication (NS-PK/AS, Kerberos, GSM); Key-agreement (Diffie-Hellman, Internet Key Exchange); Secure Web Connections (TLS/SSL); Secure Mobile Connections (WTLS); Electronic Payments (SET - Visa Mastercard, Cybercash); Secure Protocols for Mobility(Secure Mobile IP, Dynamic DNS); Part IV: Practical Hacker Attacks: Passive attacks: network scanning (TCP/SYN,UDP); Active attacks: IP spoofing, hijacking, cookie, cross-site scripting; Denial of service: ping of death, smurf, land, DDoS and rootkits (Note: these attacks are shown to explain the problems and possible solutions: reproducing them on the internet may lead to prosecution).

Courses from VU

Course:	*Introduction in Logic*
ID:	VU-LOG
Authors:	dr. R.C. de Vrijer
ECTS:	5
Classification:	1.1.1.1, 1.1.1.4, 1.1.1.5, 1.1.3
Description:	In this course the syntax and semantics of propositional and first order logic will be introduced. Deduction as proof system will be explained. The relation between semantical and syntactical methods play a major role including the core terms soundness, consistency, and completeness. After that we go into model checking with binary decision diagrams and into modal logics. Both logics have important applications in computer science.

Course:	*AI kaleidoscoop*
ID:	VU-AI
Authors:	prof. dr. F.A.H. van Harmelen
ECTS:	6
Classification:	1.1
Description:	This course gives an overview of the most important areas of artificial intelligence (among knowledge-based systems, search methods, machine learning, production systems, planning, game programmes, etc.). In the first 4 weeks the basic concepts of search methods are treated. In the following period we look in each lecture on an area as whole as well as a representative element of the area in detail. At these elements the representation of knowledge and the search for solutions is focused.

Course:	*Database I*
ID:	VU-DB1
Authors:	To be announced
ECTS:	6
Classification:	1.2.2

Description:	In this college some general principles and important aspects of relational database management systems (Dbms) are treated. Among others we talk about: the terms database, DBMS and ARE, the several types of users of DBMS, DBMS architecture (particularly the three layers architecture of ANSI/sparc), date independence, the (E)ER data model, the relational model, integrity requirements, a classification of constraints, the three types of relational question languages (relational algebra, tupel calculus and domain calculus), SQL, database design and standardization theory, catalog and DD/D (dates dictionary/directory). Also query processing and optimization, operations, recovery and concurrency control are addressed.

Courses from UKarl

Course:	*Basics of Computer Science I (Grundlagen der Informatik I)*
ID:	KA:CS1
Authors:	Studer, Sure
ECTS:	6
Classification:	1.1.1.1, 1.2.1.2, 1.2.1.4
Description:	This course lays the computer science foundations required for the Semantic Web. It deals with the following topics: object-oriented modeling in UML, logic (propositional calculus, first-order predicate logic, boolean algebra), algorithms (properties, testing), algorithms for searching and sorting (Quicksort, Heapsort, etc.), and dynamic data structures (trees, queues, stacks, etc.). The course will be held in German.

Course:	*Applied Informatics I (Angewandte Informatik I)*
ID:	KA:AI1
Authors:	Stucky, Studer
ECTS:	4.5
Classification:	1.1.1.2, 1.2.1.1., 1.2.1.2, 1.2.1.3
Description:	Design and implementation of information systems of different kind are always based on similar approaches: analysis of the existing system, conceptual modeling of the target system, and feedback with users and other participants in all phases. Main preliminaries are the right modeling concepts. This course mainly addresses the early phases of the development of database supported information systems, distributed systems for information services, intelligent systems, and software systems in general. Main topics are modeling concepts and diagram techniques for the different aspects of system design, e.g., data, object relationships, and processes. These application oriented concepts are semantically based on mathematically formulated models like description logics, UML, relational models, and Petri nets. The course will be held in German.

Course:	*Applied Informatics II (Angewandte Informatik II)*
ID:	KA:AI2
Authors:	Schmeck
ECTS:	4.5
Classification:	1.3.1, 1.3.1.1, 1.3.1.2, 1.3.1.3, 1.3.1.4, 1.3.3, 1.3.4, 1.3.7, 3.5

Description:	This course will cover various facets of electronic commerce which have to be supported by adequate and efficient information and communication systems. After a brief introduction to e-commerce the following topics will be covered: methods for describing, representing, and exchanging documents (ranging from EDI to XML), client server architectures, and business objects in the WWW (applets, servlets to CORBA, J2EE and web services), software agents, and security aspects. The course will be held in German.

3.3.2 Basic Modules - Web Infrastructure

Web Infrastructure
Description: Courses in this module may cover the basic knowledge on distributed systems, network technologies, internet technologies, mobile services, and security.

Courses from FUB

Course:	*Computer Networks*
ID:	BZ-
Authors:	Gabriele Gianini
ECTS:	4
Classification:	
Description:	The goal of this course is to give students a clear understanding of the architecture and organization of communication networks - with emphasis on higher level protocols - and of the tradeoffs involved in network protocol design. Students will also learn to use some industry-standard design and development tools and platforms. The syllabus includes: Communication architectures and paradigms; Review of TCP/IP; Socket Programming in Java; Application level protocols: SMTP, HTTP; Web Service Protocols: SOAP, WSDL, UDDI; The J2EE platform.

Course:	*Internet Technologies II*
ID:	BZ-
Authors:	Alberto Sillitti
ECTS:	4
Classification:	
Description:	The goal of this course is to learn how to develop web-enabled and mobile applications using the most recent technologies. The syllabus includes: Web applications design; Tools and languages to develop web applications; Mobile applications design; Tools and languages to develop mobile applications.

Course:	*Distributed Databases*
ID:	BZ-
Authors:	Thomas B. Hodel
ECTS:	4
Classification:	

Description:	The objective of the Distributed Databases course will cover the theory of distributed databases and the use of distributed databases in business. Lab-based seminars have the objective to design and implement concepts of a distributed database management system. The syllabus includes: Distributed DBMS Architecture; Distributed Database Design; Transaction Management; Distributed Concurrency Control; Distributed DBMS Reliability; Parallel Database Systems; Current Issues.

Course:	*Mobile Services*
ID:	BZ-
Authors:	Igor Timko
ECTS:	4
Classification:	
Description:	The goal of the course to is to provide the students with a practical, hands-on experience with a database management system that supports moving objects, and knowledge on the database technology for moving objects in general. The syllabus includes: Introduction to Moving Objects Databases; Modeling and Querying Current Movement; Modeling and Querying History of Movement; Data Structures and Algorithms for Moving Objects Types; Spatio-Temporal Indexing; Modeling and Querying Moving Objects in Networks.

Course:	*Systems Security*
ID:	BZ-
Authors:	Sabrina De Capitani Di Vimercati
ECTS:	4
Classification:	
Description:	This course is designed to develop knowledge and skills for security of distributed computer systems. In particular, the main objectives of this course are to systematically study theories, principles, and techniques of computer security. Students will learn basic cryptography, fundamentals of computer security, risks faced by computer systems, security mechanisms, operating system security, and secure systems design principles. The course covers the terminology of the field and the history of the field.

Systems

Course:	*XML and Semistructured Databases*
ID:	BZ-
Authors:	Andrea Calì
ECTS:	4
Classification:	
Description:	The objective of the XML and Semistructured Databases course is to provide students with both theoretical and practical knowledge about semistructured data. In particular, the XML language is introduced, together with a family of XML-based formalisms that are used to query and manipulate XML documents. Specifically, the course will cover expressive power of XML languages and computational complexity of tasks related to XML data, in particular XML parsing and containment of queries. Since the focus is for a data-oriented use of XML, the course will also cover techniques for storing XML data in traditional relational databases. As for practical aspects, during this course the students will learn to develop an application that queries and manipulates XML data.

Course:	*Digital Libraries*
ID:	BZ-
Authors:	Vittorio Di Tomaso
ECTS:	4
Classification:	
Description:	The course 'Digital Libraries' is aimed to students who wish to handle real-world issues of building, using and maintaining large volumes of information in digital libraries. Students will learn the fundamentals of modern information retrieval, with a particular focus on how this emerging technology complements traditional information finding skills of the librarian or archivist. The syllabus includes: Managing DL collections (Text encodings: (SGML, Unicode, XML), Text analysis for searching and classification); Fundamentals of information retrieval (Document indexing, TF*IDF, Boolean retrieval model, Vector space model, Algebraic models); Classification (Traditional classification schemes, metadata types, Dublin core, Warwick framework); DL policy, interoperability and access rights; Bibliometrics and its applications; User interfaces for querying and displaying documents; Evaluation; Collaborative filtering, Recommender systems, Reputation schilling, Authorship attribution, Plagiarism detection.

Languages

Courses from UPM

Course:	*Principles of distributed systems*
ID:	UPM-Distr.
Authors:	Ricardo Jimenez Peris, Marta Patino-Martinez
ECTS:	3
Classification:	1.3.4, 1.3.7, 2.0.1
Description:	The course will cover the foundations of distribuyed systems with strong emphasis in the most relevant research lines in the area, as well as emerging paradigms in the area. The course will start by presenting models of distributed systems (synchrony and fault models). It will present the main metrics for performance and reliability. Then, it will introduce the fundamental problems of distributed system, its formal definition, and main theoretical results, as well as the relation among the different problems. Later on, it will deal with one of the main building blocks for reliable distributed systems, reliable multicast or group communication. The formal definition of the reliable multicast properties, as well as the proponed protocols to implement them. The course will continue with the presentation of the main consistency criteria for distributed systems, as well as the protocols that implement them. The course will also introduce the techniques to attain high availability. Finally, the course will provide an overview of the hottest research topics and trenes in the distributed systems area. The objectives of the course are on one hand to provide a solid foundation for reasoning about distributed systems. On the other hand, to introduce the existing techniques, algorithms, and protocols to solve all these fundamental problems. The student should learn to model and implement distributed systems and evaluate its performance and reliability, as well as to reason about their correctness.

Courses from UniTn

Course:	*Distributed systems: design*
ID:	PSW
Authors:	Marco Ronchetti
ECTS:	6
Classification:	1.3.1, 1.3.7
Description:	Formative aims: At the end of the course the student will be familiar with various Java-based technologies for web-based distributed systems. Program of the course: Web-based distributed systems architectures: problems and solutions. The HTTP protocol. DHTML: the ingredients. Introduction to the XML world. Java technologies for the dynamic web: Servlets, Java Server Pages, JDBC, JNDI, Enterprise Java Beans. Application servers. Overview of other emerging technologies. Basic elements of transactions and JTA.

Course:	*Web information retrieval*
ID:	PSW
Authors:	XX
ECTS:	3
Classification:	1.3.6
Description:	Formative aims: The course analyzes the research of information seeking and retrieval (IS&R) and proposes a new direction of integrating research in these two areas: the fields should turn off their separate and narrow paths and construct a new avenue of research, where interaction between humans and machines, information acquisition, relevance and information use are the main issues. Program of the course: Historical remarks on Information Retrieval. The cognitive approach. Basic concepts: keywords, query syntax, documents, indexing, precision, recall. Lexical features, language parsing. Weighting and Matching, the Vector Space classical Model. Similarity metrics. Statistics of communication. Personal Relevance and Feedback Management. Consensual and aggregated relevance. Mathematical foundations: dimensionality reduction, preference relations, clustering, probabilistic retrieval, bayesian networks, classification. Adaptive Information Retrieval: effective adaptive search models. Preference queries, implicit feedback. Advanced topics: Logic and IR; the geometry of IR (hints).

Courses from VU

Course:	*Distributed Systems*
ID:	VU-DS
Authors:	prof. dr. ir. M.R. van Steen
ECTS:	6
Classification:	UNKNOWN
Description:	We discuss the issues concerning the development of middleware systems for largescale computer networks. Principles that are discussed include communication, processes, naming, consistency and replication, fault tolerance, and security. These principles are further explained by means of different paradigms applied to distributed systems: object-based systems (CORBA), distributed file systems (NFS), document-based systems (the Web), and coordination-based systems (publish/subscribe systems and Jini). Explicit attention is paid to the practical feasibility and scalability of various solutions. For this reason, experimental (research) systems as well as commercially available systems are discussed.

Course:	*Network Programming*
ID:	VU-NP
Authors:	dr. ir. G.E.O. Pierre
ECTS:	9
Classification:	UNKNOWN
Description:	The course discusses a number of programming facilities for the development of network applications. Attention is paid to designing and implementing applications with threads, sockets, RMI/RPC, CGI/BIN, servlets, PHP. In addition, attention is paid to security and modern enabling technologies like peer-to-peer systems.

Courses from UKarl

Course:	*Computer Networks (Telematik)*
ID:	KA:CNE
Authors:	Zitterbart
ECTS:	8
Classification:	1.3.7
Description:	This course is the basis for topics covering telecommunication and computer science. It covers communication systems such as the internet, ISDN, satellite communication, local networks (e.g. ethernet), and mobile communication. This includes communications engineering (with its physical aspects) and the protocols required to enable computer communication. The course is held in German.

3.3.3 Basic Modules - Basic Semantic Web Technologies

Basic Semantic Web Technologies
Description: Courses in this module cover the basic representation languages for the Semantic Web including XML, RDF, RDFS, and OWL

Courses from FUB

Course:	*Semantic Web technologies*
ID:	BZ-
Authors:	Jos de Bruijn
ECTS:	4
Classification:	
Description:	The course will present the cutting-edge technologies from the semantic web vision: the RDF data model; the SPARQL query language; the OWL web ontology language; Semantic Web Services; F-Logic for the semantic web; RuleML. A laboratory will be held with, among other things, Jena.

Course:	*Knowledge Representation*
ID:	BZ-
Authors:	Enrico Franconi
ECTS:	4
Classification:	
Description:	The aim of the course is to provide students with an understanding of the formal foundations of classical logic-based knowledge representation languages, and with an overview of the reasoning methods for them. Most of the course will focus on description Logics and on ontology languages. Other formalisms will be introduced, such as modal logics, temporal logics and epistemic logics. The syllabus includes: A review of computational logic; Knowledge Representation; Structural description logics; Propositional description logics; Knowledge bases; Modal logics; Logics and databases.

Course:	*Knowledge Bases and Databases*
ID:	BZ-
Authors:	Enrico Franconi
ECTS:	4
Classification:	

Description:	This course will offer few advanced topics about the application of knowledge representation technologies to database problems: this includes: information access mediated by ontologies; Data integration systems, Consistent query answering, Semantics Driven Support for Query Formulation.

Courses from UPM

Course:	*Ontologies and the Semantic Web*
ID:	UPM-OSW
Authors:	Asuncion Gomez-Perez
ECTS:	3
Classification:	1.0, 1.0.1, 1.0.4, 1.0.5, 1.0.6, 1.0.7, 2.0, 2.0.1, 2.0.2, 2.1, 2.2, 2.2.1, 2.2.2, 2.3, 2.3.1, 2.3.2, 3.6
Description:	The Semantic Web is an extension of the current Web in which information is given well-defined meaning (by means of ontologies), better enabling computers and people to work in cooperation. It is based on the idea of having data on the Web (by means of metadata and annotations) defined and linked such that it can be used for more effective discovery, automation, integration, and reuse across various applications using, for instance, semantic web services. Ontological Engineering refers to the set of activities that concern the ontology development process, the ontology life cycle, the methods and methodologies for building ontologies, and the tool suites and languages that support them. Primary goals of this course are to acquaint students, researchers and developers of information systems with the basic concepts and major issues of Semantic Web and Ontological Engineering, as well as to make ontologies more understandable to those computer science engineers that integrate ontologies into their information systems. We have paid special attention to the influence that ontologies have on the Semantic Web. Pointers to the Semantic Web appear in all the chapters, specially, in the chapter on ontology languages and tools.

Courses from UniTn

Course:	*Web Languages*
ID:	PSW
Authors:	Maurizio Marchese, Marco Pistore
ECTS:	12
Classification:	1.3.4, 2.0.1, 2.0.2, 2.3.1
Description:	Program of the course: Introduction to Web-services: The Concept of software as a service, What are web services? Web services: types and characteristics Review to Distributed Computing Infrastructure: Internet Protocols, Middleware, The Client/Server Model, Characteristics of Inter-Process Communication, Non-message based Forms of Middleware, Message based Forms of Middleware, Event-Driven Processing Mechanisms , Message Oriented Middleware, Integration brokers, Transaction Oriented Middleware The service-oriented architecture (SOA): Roles of interaction in the service-oriented architecture, Operations in the service-oriented architecture (Publish, Find, Bind), Aggregated services Languages for Web Services: SOAP: Simple Object Access Protocol; WSDL: Web Services Description Language, UDDI: Universal Description, Discovery, and Integration, WSDL to UDDI Mapping Model; RDF: Resource Description Framework for modeling meta-data about the resources of the web: OWL: Web Ontology Language Implementing Web-services: Leading vendors' approach to web-services Business processes and web services: composing web services into business processes; BPEL: the Business Process Execution Language; BPEL and WSDL; communication primitives in BPEL; conditional, concurrent and iterative processing in BPEL; fault handling, process scopes, and compensation in BPEL; message correlation in BPEL; event handling in BPEL. Coordination of web services: choreography and orchestration; web service choreography languages; web service coordination and web service transactions. Semantic web services: extending web service descriptions with semantic annotations; the OWL-S language; defining composite web services in OWL-S

Courses from VU

Course:	*Web-based knowledge representation*
ID:	VU-WKR
Authors:	prof. dr. F.A.H. van Harmelen
ECTS:	6
Classification:	1.3.1.1, 1.3.1.2, 1.3.1.3, 1.3.1.4, 2.1, 2.2.1, 2.3.1, 2.7.1, 2.7.6
Description:	The WWW offers large possibilities for the use of existing and new knowledge representation techniques. An important aim is to transform the current web (pages which are intended for human readers) to a web in which knowledge has been modelled explicitly, so that these can be used by machines. This is an important step to the realization of more intelligent search engines, information filters, adaptive Internet sites, etc. In this course we treat a number of techniques which can be seen to be the basis of this new generation of the web: techniques (for example ontologies), stadard model web techniques such as XML, and knowledge representation languages for use on the web (RDF, OWL). This course discusses also a number of application scenarios, such as e commerce, search and navigation, and format-independent publish.

Course:	*Information Retrieval*
ID:	VU-IR
Authors:	To be announced
ECTS:	6
Classification:	1.2, 1.2.1, 3.1
Description:	To be given.

Courses from UKarl

Course:	*Intelligent Systems in the WWW (Intelligente Systeme im WWW)*
ID:	KA:ISW
Authors:	Hitzler, Sure
ECTS:	4.5
Classification:	1.1.1.3, 1.1.1.5, 1.3.1, 1.3.1.1., 1.3.1.2, 2.1, 2.2, 2.2.1, 2.3, 2.3.1, 2.4, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 2.7
Description:	For the future web knowledge in electronic commerce and internet portals plays a key role. However, knowledge can only be imparted using semantics. The "Semantic Web", an expression coined by Tim Berners-Lee, the inventor of the World Wide Web, describes the intelligent application of the WWW for the transmission and exchange of content, both comprehensible for people and machines. Basis for the Semantic Web are methods from conceptual modeling, database programming, and artificial intelligence, from which innovative technologies and services develop to share knowledge in an easier way. In specific, XML, RDF(S), and OWL will be introduced. Logics and rules are another core topic. This course covers the mentioned areas and shows how software agents of the Semantic Web can be applied to knowledge portals, for B2B, and B2C. The course will be held in German.

Course:	*Knowledge Discovery*
ID:	KA:KDD
Authors:	Abecker
ECTS:	4.5
Classification:	1.3.2, 1.3.6
Description:	This course gives an overview of methods for knowledge generation from structured data and text. This includes: techniques for preprocessing and integration of data (e.g., in data warehouses), OLAP-techniques for the interactive analysis of large data repositories, (semi-)automatic approaches for knowledge generation from structured data, and methods for knowledge extraction from text. The focus of this course lies on machine learning approaches. Its application will be shown through concrete examples. The course will be held in German.

Course:	*Dynamic and Interoperable Systems in Knowledge Management (Dynamische und Interoperable Systeme im Wissensmanagement)*
ID:	KA:DIS

Authors:	Sure
ECTS:	4.5
Classification:	1.3.4, 2.1, 3.4, 3.5, 3.6
Description:	This course lies a focus on dynamic and interoperable systems for knowledge management. In specific, the following topics will be treated: web services, peer-to-peer, grids, workflows, ontologies and metadata. The course will be held in German.

3.3.4 Basic Modules - Formal Foundations of Knowledge Representation

Formal Foundations of Knowledge Representation
Description: Courses in this module may cover the basic knowledge on logic, formal methods, knowledge representation and reasoning, theory of computing

Courses from FUB

Course:	*Theory of Computing*
ID:	BZ-
Authors:	Diego Calvanese
ECTS:	8
Classification:	
Description:	The objective of the Theory of Computing course is to introduce and study abstract, mathematical models of computation (such as finite state machines, push down machines, and Turing machines), and to use the abstract machine models to study the ability to solve computational problems, by identifying both the intrinsic limitations of computing devices, and the practical limitations due to limited availability of resources (time and space). A second objective is to show how to reason and prove properties about computing in a precise, formal, abstract way. The syllabus includes: Regular languages (finite automata and regular expressions); Context-free languages (context-free grammars, pushdown automata); Turing Machines; Undecidability; Computational complexity; NP-completeness; Polynomial hierarchy.

Course:	*Knowledge Representation*
ID:	BZ-
Authors:	Enrico Franconi
ECTS:	4
Classification:	

Description:	The aim of the course is to provide students with an understanding of the formal foundations of classical logic-based knowledge representation languages, and with an overview of the reasoning methods for them. Most of the course will focus on description Logics and on ontology languages. Other formalisms will be introduced, such as modal logics, temporal logics and epistemic logics. The syllabus includes: A review of computational logic; Knowledge Representation; Structural description logics; Propositional description logics; Knowledge bases; Modal logics; Logics and databases.

Course:	*Computational Logic*
ID:	BZ-
Authors:	Pablo Fillottrani
ECTS:	4
Classification:	There are no prerequisites in terms of courses to attend. Students must be familiar with propositional and first order logic, and must have practical experience in logic programming. Objectives The objective of this course is to offer a comprehensive introduction of the methods and techniques in Computational Logic. Although the course has a formal background, it includes a strong practical part in using automated tools and with a review of applications. The syllabus includes: Computational Logic: motivation and importance of the field; Propositional and First Order Logic: deduction, proof theory, automated theorem proving; Higher Order Logic; Induction and Abduction; Non-monotonic reasoning; Applications of Computational Logic.
Description:	

Course:	*Non-classical Logics*
ID:	BZ-
Authors:	Rosella Gennari
ECTS:	4
Classification:	

Description:	Modal logic is usually viewed as the logic of 'necessity' in philosophy, and of 'provability' in mathematics. But computer science has advocated another view: that of modal languages as compact yet expressive languages for describing relational structures. In fact relational structures – hence modal logic – lie at the core of computer science areas such as computational linguistics, planning and (concurrent) program verification. This course will present the basics of modal logic, emphasizing its semantic and computational properties. The syllabus includes: Basic concepts: relational structures, in particular transition systems and trees; modal languages; semantics of modal logics; proof systems for modal logics; Models and satisfiability:basic model construction techniques; simulations and bisimulations; the standard translation; Frames and validity; Soundness and completeness of the basic modal logic; Decidability of the basic modal logic.

Course:	*Formal Methods*
ID:	BZ-
Authors:	Alessandro Artale
ECTS:	4
Classification:	
Description:	In this module students will develop a deeper understanding of technologies based on applying formal methods for the specification and verification of hardware systems. Students will learn the most important techniques based on Model Checking to check properties of a system. In particular, the student will be able to understand how to formally specify an hardware system by means of transition systems and how to express computation properties by means of formulas in Temporal Logic. Both Linear Temporal Logic (LTL) and Computation Tree Logic (CTL) will be studied together with efficient algorithms for model checking formulas in these logics. During the lab a tutorial on NuSMV will introduce the student to one of the most successfull software used in industrial applications to specify and test syncronous concurrent systems and critical software.

Course:	*Programming Languages*
ID:	BZ-
Authors:	Alessandro Cimatti
ECTS:	4
Classification:	

Description:	The aim of the course is twofold. On one side, we aim at building substantial hands-on programming skills with LISP and PROLOG. On the other side, we will provide basics notions in functional, logic and constraint programming. LISP: Symbols; basic functions; definitions, predicates, scoping; recursion, tail recursion, and iteration; lambdas; properties, a-lists, arrays; reading and printing; macros; memory management, destructive lisp; interpretation and compilation; foundations, elements of lambda caclulus. PROLOG: Facts, rules and queries; matching and proof search; recursion; terms; cuts and negation; database manipulation; collecting solutions; working with files. CONSTRAINT LOGIC PROGRAMMING: Semantics of logic programs; constraints; constraint handling rules; principles of constraint solving (variable elimination, local consistency); examples of common constraint systems (Boolean, linear polynomilal, finite domains, interval).

Courses from UPM

Courses from UniTn

Course:	*Mathematical logic*
ID:	PSW
Authors:	Stefano Baratella
ECTS:	6
Classification:	1.1.1
Description:	Formative aims: Formal methods are increasingly used as powerful specification, verification and early debugging methods in the development of industrial SW and HW systems. This course provides an introduction to Formal Techniques and Tools for the specification and verification of Hardware and Software platforms. Apart from an introduction on formal techniques and their benefits, the course will concentrate mainly on formal verification and techniques and, in particular, on Model Checking (MC). A laboratory will be given in which the students will experience MC techniques by means of the MC NuSMV and SPIN. Program of the course: The course covers propositional logic, first order logic and basic modal logics. Topics in logic include syntax, semantics, models, logical entailment, proofs, soundness, completeness, and decidability. Reasoning methods include the truth table method, natural deduction, the Davis-Putnam procedure, resolution and tableaux methods.

Course:	*Formal Methods*
ID:	PSW
Authors:	Roberto Sebastiani
ECTS:	12
Classification:	1.1.3

Description:	Formative aims: Making students capable to use the basic logic methodologies for representing knowledge in a computer, and for performing automated inference on it. To reach the goal, we will provide a rigorous introduction to logic form a representational and computational perspective. Program of the course: The main topics presented in the course are: • Introduction on formal techniques and their benefits • Formal specification & formal validation • Model Checking (MC) • Temporal logics: LTL & CTL • Ordered Binary Decision Diagrams (OBDDs) • Explicit-State MC, LTL MC • Symbolic MC, CTL MC • SAT-based MC, • advanced techniques like: – abstraction in MC – PSL/sugar – MC with Timed and Hybrid Systems – verification of RTL circuits – SW verification

Courses from VU

Course:	*Automated Reasoning for AI*
ID:	VU-AR
Authors:	dr. K.S. Schlobach, dr. H.E. Wache, prof. dr. F.A.H. van Harmelen
ECTS:	6
Classification:	1.1.1.2, 1.1.3
Description:	The course will be structured in three modules. In each of these modules a practical problem will be introduced, a logic-based representation proposed, and the basic techniques for automated reasoning in this language studied in a practical, hands on, way. In a nutshell, we plan to cover: 1. Propositional Logic for scheduling, and satisfiability checking with Davis Putnam, 2. Allens interval logic for Planning, with constraint propagation in Temporal Constraint Networks, and 3. Description logics for classification, with Tableau calculi for subsumption.

Course:	*Advanced Logics*
ID:	VU-AL
Authors:	dr. R.C. de Vrijer
ECTS:	4
Classification:	1.1.1.4, 1.1.3
Description:	Modal logic are already shortly introduced in the course introduction logic. This course deepens the insight and skills in modal logic, with a view to applications in data processing and artificial intelligence. Modal logic exists in several variants, for example time logic, logic, dynamic logic, deontische logic. All these forms have their own specific applications. But the theoretical framework is always the same: Kripke-models with possible worlds. Important technical appliances for investigating modal logic are comparisons of Kripke models.

Courses from UKarl

Course:	*Intelligent Systems in the WWW (Advanced) (Intelligente Systeme im WWW II)*
ID:	KA:IS2
Authors:	Hitzler, Sure
ECTS:	4.5
Classification:	1.1, 1.1.1, 1.1.2, 1.1.3
Description:	Goal of this course will be to extend knowledge on logics and reasoning. The course will be held in German.

3.3.5 Basic Modules - Information and Knowledge Systems

Information and Knowledge Systems
Description: Courses in this module may cover the basic knowledge on knowledge management, information systems, advanced database technologies, semistructured data.

Courses from FUB

Course:	*Knowledge Bases and Databases*
ID:	BZ-
Authors:	Enrico Franconi
ECTS:	4
Classification:	
Description:	This course will offer few advanced topics about the application of knowledge representation technologies to database problems: this includes: information access mediated by ontologies; Data integration systems, Consistent query answering, Semantics Driven Support for Query Formulation.

Course:	*XML and Semistructured Databases*
ID:	BZ-
Authors:	Andrea Calì
ECTS:	4
Classification:	
Description:	The objective of the XML and Semistructured Databases course is to provide students with both theoretical and practical knowledge about semistructured data. In particular, the XML language is introduced, together with a family of XML-based formalisms that are used to query and manipulate XML documents. Specifically, the course will cover expressive power of XML languages and computational complexity of tasks related to XML data, in particular XML parsing and containment of queries. Since the focus is for a data-oriented use of XML, the course will also cover techniques for storing XML data in traditional relational databases. As for practical aspects, during this course the students will learn to develop an application that queries and manipulates XML data.

Course:	*Distributed Databases*
ID:	BZ-
Authors:	Thomas B. Hodel
ECTS:	4

Classification:	
Description:	The objective of the Distributed Databases course will cover the theory of distributed databases and the use of distributed databases in business. Lab-based seminars have the objective to design and implement concepts of a distributed database management system. The syllabus includes: Distributed DBMS Architecture; Distributed Database Design; Transaction Management; Distributed Concurrency Control; Distributed DBMS Reliability; Parallel Database Systems; Current Issues.

Course:	*Temporal and Spatial Databases*
ID:	BZ-
Authors:	Johann Gamper
ECTS:	4
Classification:	
Description:	New course, syllabus to be defined yet

Course:	*Foundations of Databases*
ID:	BZ-
Authors:	Werner Nutt
ECTS:	4
Classification:	
Description:	The aim of the course is to deepen the knowledge of students about the formal concepts underlying database systems. Semantic aspects such as containment and equivalence of queries, modeling incomplete information, information integration and expressive power of query languages will be considered as well as computational aspects such as evaluation, optimization, and rewriting of queries as well as the computational complexity of selected query languages. The syllabus includes: Relational query languages, relational calculus; Conjunctive queries, equivalence and containment of conjunctive queries, query processing and optimization; Datalog and recursion, datalog evaluation; Incomplete information, possible and certain answers; Information integration, query rewriting.

Course:	*Data Warehousing and Data Mining*
ID:	BZ-
Authors:	Michael H. Boehlen and Arturas Mazeika
ECTS:	8
Classification:	

Description:	Enable students to understand and implement classical algorithms in data mining and data warehousing. The syllabus includes: Visual data mining; * Statistical primer: parameter estimation, quality metrics of parameter estimation, hypothesis testing, Bayes theorem, histograms, scatter plots, regression, Classification algorithms, Clustering algorithms, Association rules, Web mining, Spatial mining, Temporal mining, Data Warehousing, OLAP, The multi-dimensional join, Data integration, Data quality.

Courses from UPM

Courses from UniTn

Course:	*Organizational Information Systems*
ID:	PSW
Authors:	Yannis Velagrakis
ECTS:	6
Classification:	1.2
Description:	Introduction – what are organizational information systems? The structure and operation of business organizations, business processes; System and technology background; Design and implementation of organizational information systems – artifacts and processes, big bang vs phased; Training and operation; Types of organizational information systems: Customer Relationship Management, Supply Chain Management, Product Lifecycle Management, Supplier Relationship Management, Enterprise Portals, Business Intelligence, Mobile Business and Marketplace, supporting information systems..

Courses from VU

Course:	*Knowledge Management and Modelling*
ID:	VU-KMM
Authors:	prof. dr. J.M. Akkermans, prof. dr. A.T. Schreiber
ECTS:	6
Classification:	1.0.1, 1.0.2, 2.3.2, 2.7.1
Description:	Knowledge management is a relatively new discipline which has as its aim the efficiency improvement of the production factor ”knowledge” and of the related business processes (knowledge creation, distribution, application and maintenance). The course ”Knowledge Management and Modelling” is concerned with the organizational aspects of knowledge management, as well as the question how knowledge can be described with the support of modern information-modeling techniques. The notion of pattern-based knowledge modeling is a key issue in the knowledge management process. Students carry out a knowledge-management project in small project groups in a problem domain and organization of choice.

Course:	*Knowledge Based Systems*
ID:	VU-KBS
Authors:	dr. M. Klein
ECTS:	4
Classification:	1.1
Description:	Knowledge-based systems are viewed in this course at two levels: the symbol level and the knowledge level. At the symbol level we look for the representation which are able to be used to represent several types knowledge and to reason about it. The course treats the representation and reasoning over time and space and reasoning with uncertain or incomplete knowledge. At the knowledge level an analysis is made of the different kind of tasks which can be carried out by a system and of the type knowledge which is required for a certain task. Examples which will be discussed in this course are classification, configuration and diagnosis. For each of these applications the relevant knowledge types will be discussed, as well as a number of practical systems.

Courses from UKarl

Course:	*Knowledge Management (Wissensmanagement)*
ID:	KA:KMA
Authors:	Studer
ECTS:	4.5
Classification:	1.0.1, 2.7.1
Description:	The course covers the different kinds of knowledge used in knowledge management, the corresponding processes (knowledge generation, access, and application), and methods for the implementation of knowledge management solutions. The focus lies on computer science methods to support knowledge management in intranet environments, including sharing of knowledge and navigation of knowledge structures. This includes ontologies and topic maps as modeling primitives, knowledge portals and case-based reasoning. Further, the foundations of data warehousing are introduced. Typical knowledge management applications are discussed. The course will be held in German.

Course:	*Information and Knowledge Management (Informations- und Wissensmanagement)*
ID:	KA:IKM
Authors:	Böhm, Studer
ECTS:	4.5
Classification:	1.2, 1.2.1, 1.2.2
Description:	The course is split into two parts: the foundations of database systems and knowledge management. In detail the following topics will be covered: relational modeling (dependencies, normalization), SQL, object-oriented modeling (ODMG standard), database development (mapping of conceptual to logical models), transactions, architecture and implementation of database systems, ontology-based knowledge management, topic maps, case-based reasoning, and knowledge management applications. The course will be held in German.

Course:	*Database Systems (Datenbanksysteme)*
ID:	KA:DBS
Authors:	Stucky
ECTS:	4.5
Classification:	1.2.2

Description:	Database systems (DBS) play a central role in today's enterprises. Internal and external data are stored and applied through databases. The correct administration and organization of this data allows simultaneous access of several users. It is the organizational and operational basis for the complete workflows and processes within the enterprise. The course introduces the theory of databases (relational model, distributed data model, hierarchical model), includes the database languages and systems, considers object-oriented databases, introduces the basics of multiuser-access, and the physical data organization. Further, typical database problems such as correctness and integrity, recovery options, and synchronization of parallel transactions are addressed. The course will be held in German.

Course:	*Database Systems and XML (Datenbanksysteme und XML)*
ID:	KA:DBX
Authors:	Oberweis
ECTS:	4.5
Classification:	1.2.2, 1.3.1, 1.3.1.1, 1.3.1.2, 1.3.1.3, 1.3.1.4
Description:	Databases have been proven successfully for the management of large amounts of data. The oldest database model, the hierarchical model, has been replaced through other models such as the relational or object-oriented model. However, in the last years it has again gained importance, especially through the eXtensible Markup Language (XML). XML is a data format to represent semi-structured data. The consistent and reliable storage of XML documents requires databases able to cope with these. This course will cover the following topics: XML query languages, storage of XML-documents, indexing of XML-documents, and general concepts of XML-oriented database systems. The course will be held in German.

3.3.6 Advanced Modules - FUB

Advanced Module - Language and Communication Technologies

Language and Communication Technologies

Keywords: grammar formalisms, computer lexicography, information retrieval, mathematical methods and logic, linguistics

Description: The module was designed with input from industry professionals to give students a solid foundation in language and communication technologies so that they will be able to grow and change along with this rapidly developing and exciting discipline. Students will gain knowledge of fundamental techniques in speech and language processing and their application in domains such as semantic web, digital libraries, question answering, dialogue systems, machine translation and information retrieval. In particular, this module provides extended knowledge of the modern formal language and grammar theories and the methodology and techniques of language description, as well as the ability to implement them in Computational Linguistics.

Structure:

Course:	*Computational Linguistics*
ID:	BZ-
Authors:	Raffaella Bernardi
ECTS:	4
Classification:	
Description:	This course presents a graduate-level introduction to natural language processing, the primary concern of which is the study of human language use from a computational perspective. The principal objectives of the course are to provide students with a broad overview of the field, and prepare them for further study computational linguistics. No previous knowledge of linguistic theory and linguistic applications is assumed. The syllabus includes: Ambiguity, History of the field, Phonology, Morphology, Syntax, Semantics, Pragmatics, Formal Languages and Finte State Autonoma, Formal Grammars, Parsing, NLP and Logic.

Course:	*Introduction to linguistics*
ID:	BZ-
Authors:	Daniela Veronesi
ECTS:	4
Classification:	

Description:	The course provides a general introduction to linguistics and to the different levels of linguistic analysis and aims at giving students a theoretical background for further work in computational applications. Students are introduced to the core areas of general linguistics such as phonetics and phonology, morphology, syntax and semantics. Textual and pragmatic aspects will also be addressed. Particular attention will be given to links between aspects of general linguistics and CL work. Lectures will be integrated by exercise sessions, wich will give students the opportunity to apply theoretical notions to specific aspects of languages and communicative events by analysing and working with spoken and written texts in English, Italian and/or German.

Course:	*Digital Libraries*
ID:	BZ-
Authors:	Vittorio Di Tomaso
ECTS:	4
Classification:	
Description:	The course 'Digital Libraries' is aimed to students who wish to handle real-world issues of building, using and maintaining large volumes of information in digital libraries. Students will learn the fundamentals of modern information retrieval, with a particular focus on how this emerging technology complements traditional information finding skills of the librarian or archivist. The syllabus includes: Managing DL collections (Text encodings: (SGML, Unicode, XML), Text analysis for searching and classification); Fundamentals of information retrieval (Document indexing, TF*IDF, Boolean retrieval model, Vector space model, Algebraic models); Classification (Traditional classification schemes, metadata types, Dublin core, Warwick framework); DL policy, interoperability and access rights; Bibliometrics and its applications; User interfaces for querying and displaying documents; Evaluation; Collaborative filtering, Recommender systems, Reputation schilling, Authorship attribution, Plagiarism detection.

Course:	*Human Computer Interaction*
ID:	BZ-
Authors:	Andrea Molinari
ECTS:	4
Classification:	

Description:	The course wants to stress the importance of good interfaces and the relationship of interface design to effective human interaction with computers. The course is concerned with design, implementation, and evaluation of software interfaces. On completion of the course, the participant will have theoretical knowledge and practical experiences in the fundamental aspects of designing, implementing and evaluating software interfaces. Theoretical class lectures will be augmented by case studies of interface successes and failures. The course will also introduce the participant to novel interfaces that go beyond what we normally see in today's graphical user interfaces. An important part of the course will be devoted to the study and commenting of ACM and IEEE papers taken from latest HCI conferences.

Course:	*Intelligent Interfaces*
ID:	BZ-
Authors:	Massimo Zancanaro, Fabio Pianesi
ECTS:	4
Classification:	
Description:	Multimodal Intelligent Interfaces represent an emerging interdisciplinary research direction, involving spoken language understanding, natural language understanding, image processing, computer vision, pattern recognition, experimental psychology, and others. These technologies aim at efficient, convenient and natural interaction and communication between computers and human users, thus reaching the ultimate goal of enabling users to interact with computers using everyday skills. The course intends to provide an overview of the issues in design and evaluation of Multimodal Intelligent Interfaces with particular emphasis on the life-cycle. The program will cover the topics of multimodal, tangible and conversational interfaces with special emphasis on the need of informed design and evaluation. Topics are covered from a broad multidisciplinary perspective, with an emphasis on real-world users and usage contexts. In addition to weekly classroom lectures, guest lectures, and discussion, this class includes a hands-on practicum component in which students participate in state-of-the-art research and interface design to complete a team project.

Course:	*Text Processing*
ID:	BZ-
Authors:	Bernardo Magnini

ECTS:	4
Classification:	
Description:	Understanding the content expressed by written texts is one the more challenging topic in Artificial Intelligence as well as a crucial area of technological development in Information Access. The course will provide basic notions in Text Processing according to both data-driven and knowledge-based methodologies and technologies. Students will be introduced to text processing technologies, from morpho-syntactic analysis to content extraction. Implemented tools and application scenarios will serve as exemplification of concrete use of fundamental techniques. The course will review basic methods and technological achievements in text processing and content extraction from texts. State of art approaches in Part of Speech Tagging, Shallow Parsing, Terminology Recognition, Named Entities Recognition and Word Sense Disambiguation will be addressed in depth.

Advanced Module - Information Systems

Information Systems
Keywords: Foundations of databases, advanced database applications, digital libraries, distributed information systems Description: This module aims to provide students with a detailed theoretical and practical knowledge of how advanced database management systems (DBMS) are implemented, how efficient applications are designed and implemented to work on DBMS, and how DBMS may be linked to form distributed database systems. Structure:

Course:	*Digital Libraries*
ID:	BZ-
Authors:	Vittorio Di Tomaso
ECTS:	4
Classification:	

Description:	The course 'Digital Libraries' is aimed to students who wish to handle real-world issues of building, using and maintaining large volumes of information in digital libraries. Students will learn the fundamentals of modern information retrieval, with a particular focus on how this emerging technology complements traditional information finding skills of the librarian or archivist. The syllabus includes: Managing DL collections (Text encodings: (SGML, Unicode, XML), Text analysis for searching and classification); Fundamentals of information retrieval (Document indexing, TF*IDF, Boolean retrieval model, Vector space model, Algebraic models); Classification (Traditional classification schemes, metadata types, Dublin core, Warwick framework); DL policy, interoperability and access rights; Bibliometrics and its applications; User interfaces for querying and displaying documents; Evaluation; Collaborative filtering, Recommender systems, Reputation schilling, Authorship attribution, Plagiarism detection.

Course:	*XML and Semistructured Databases*
ID:	BZ-
Authors:	Andrea Calì
ECTS:	4
Classification:	
Description:	The objective of the XML and Semistructured Databases course is to provide students with both theoretical and practical knowledge about semistructured data. In particular, the XML language is introduced, together with a family of XML-based formalisms that are used to query and manipulate XML documents. Specifically, the course will cover expressive power of XML languages and computational complexity of tasks related to XML data, in particular XML parsing and containment of queries. Since the focus is for a data-oriented use of XML, the course will also cover techniques for storing XML data in traditional relational databases. As for practical aspects, during this course the students will learn to develop an application that queries and manipulates XML data.

Course:	*Foundations of Databases*
ID:	BZ-
Authors:	Werner Nutt
ECTS:	4
Classification:	

Description:	The aim of the course is to deepen the knowledge of students about the formal concepts underlying database systems. Semantic aspects such as containment and equivalence of queries, modeling incomplete information, information integration and expressive power of query languages will be considered as well as computational aspects such as evaluation, optimization, and rewriting of queries as well as the computational complexity of selected query languages. The syllabus includes: Relational query languages, relational calculus; Conjunctive queries, equivalence and containment of conjunctive queries, query processing and optimization; Datalog and recursion, datalog evaluation; Incomplete information, possible and certain answers; Information integration, query rewriting.

Course:	*Data Warehousing and Data Mining*
ID:	BZ-
Authors:	Michael H. Boehlen and Arturas Mazeika
ECTS:	8
Classification:	
Description:	Enable students to understand and implement classical algorithms in data mining and data warehousing. The syllabus includes: Visual data mining; Statistical primer: parameter estimation, quality metrics of parameter estimation, hypothesis testing, Bayes theorem, histograms, scatter plots, regression, Classification algorithms, Clustering algorithms, Association rules, Web mining, Spatial mining, Temporal mining, Data Warehousing, OLAP, The multi-dimensional join, Data integration, Data quality.

Course:	*Distributed Databases*
ID:	BZ-
Authors:	Thomas B. Hodel
ECTS:	4
Classification:	
Description:	The objective of the Distributed Databases course will cover the theory of distributed databases and the use of distributed databases in business. Lab-based seminars have the objective to design and implement concepts of a distributed database management system. The syllabus includes: Distributed DBMS Architecture; Distributed Database Design; Transaction Management; Distributed Concurrency Control; Distributed DBMS Reliability; Parallel Database Systems; Current Issues.

Course:	*Temporal and Spatial Databases*
ID:	BZ-
Authors:	Johann Gamper
ECTS:	4
Classification:	
Description:	New course, syllabus to be defined yet

Advanced Module - Formal Methods for Artificial Intelligence

Formal Methods for Artificial Intelligence
Keywords: Knowledge Representation, advanced logic systems, foundations of databases

Description: This module combines the study of advanced formal techniques for knowledge representation and reasoning, with their application to the semantic web field. This module is concerned with techniques for the declarative representation of knowledge and inference methods based on formalized knowledge. Introduced are standard representation formalisms for various kinds of knowledge (like temporal, dynamic, categorical, or grammatical knowledge). The mathematical properties of the formalisms are discussed. Calculi for inferring knowledge are given and analyzed. Principles for designing and building knowledge-based systems are introduced, and applications of knowledge representation and reasoning techniques to artificial intelligences are covered. The successful completion of this module enables students to understand and create knowledge representation formalisms, to analyze, design, and use algorithms for drawing inferences from formal knowledge, and to build and apply knowledge-based systems.

Structure:

Course:	*Knowledge Bases and Databases*
ID:	BZ-
Authors:	Enrico Franconi
ECTS:	4
Classification:	
Description:	This course will offer few advanced topics about the application of knowledge representation technologies to database problems: this includes: information access mediated by ontologies; Data integration systems, Consistent query answering, Semantics Driven Support for Query Formulation.

Course:	*Non-classical Logics*
ID:	BZ-
Authors:	Rosella Gennari
ECTS:	4

Classification:	
Description:	Modal logic is usually viewed as the logic of 'necessity' in philosophy, and of 'provability' in mathematics. But computer science has advocated another view: that of modal languages as compact yet expressive languages for describing relational structures. In fact relational structures – hence modal logic – lie at the core of computer science areas such as computational linguistics, planning and (concurrent) program verification. This course will present the basics of modal logic, emphasizing its semantic and computational properties. The syllabus includes: Basic concepts: relational structures, in particular transition systems and trees; modal languages; semantics of modal logics; proof systems for modal logics; Models and satisfiability:basic model construction techniques; simulations and bisimulations; the standard translation; Frames and validity; Soundness and completeness of the basic modal logic; Decidability of the basic modal logic.

Course:	*Semantic Web technologies*
ID:	BZ-
Authors:	Jos de Bruijn
ECTS:	4
Classification:	
Description:	The course will present the cutting-edge technologies from the semantic web vision: the RDF data model; the SPARQL query language; the OWL web ontology language; Semantic Web Services; F-Logic for the semantic web; RuleML. A laboratory will be held with, among other things, Jena.

Course:	*Computational Linguistics*
ID:	BZ-
Authors:	Raffaella Bernardi
ECTS:	4
Classification:	

Description:	This course presents a graduate-level introduction to natural language processing, the primary concern of which is the study of human language use from a computational perspective. The principal objectives of the course are to provide students with a broad overview of the field, and prepare them for further study computational linguistics. No previous knowledge of linguistic theory and linguistic applications is assumed. The syllabus includes: Ambiguity, History of the field, Phonology, Morphology, Syntax, Semantics, Pragmatics, Formal Languages and Finte State Autonoma, Formal Grammars, Parsing, NLP and Logic.

Course:	*XML and Semistructured Databases*
ID:	BZ-
Authors:	Andrea Calì
ECTS:	4
Classification:	
Description:	The objective of the XML and Semistructured Databases course is to provide students with both theoretical and practical knowledge about semistructured data. In particular, the XML language is introduced, together with a family of XML-based formalisms that are used to query and manipulate XML documents. Specifically, the course will cover expressive power of XML languages and computational complexity of tasks related to XML data, in particular XML parsing and containment of queries. Since the focus is for a data-oriented use of XML, the course will also cover techniques for storing XML data in traditional relational databases. As for practical aspects, during this course the students will learn to develop an application that queries and manipulates XML data.

Course:	*Knowledge Representation*
ID:	BZ-
Authors:	Enrico Franconi
ECTS:	4
Classification:	

Description:	The aim of the course is to provide students with an understanding of the formal foundations of classical logic-based knowledge representation languages, and with an overview of the reasoning methods for them. Most of the course will focus on description Logics and on ontology languages. Other formalisms will be introduced, such as modal logics, temporal logics and epistemic logics. The syllabus includes: A review of computational logic; Knowledge Representation; Structural description logics; Propositional description logics; Knowledge bases; Modal logics; Logics and databases.

Course:	*Foundations of Databases*
ID:	BZ-
Authors:	Werner Nutt
ECTS:	4
Classification:	
Description:	The aim of the course is to deepen the knowledge of students about the formal concepts underlying database systems. Semantic aspects such as containment and equivalence of queries, modeling incomplete information, information integration and expressive power of query languages will be considered as well as computational aspects such as evaluation, optimization, and rewriting of queries as well as the computational complexity of selected query languages. The syllabus includes: Relational query languages, relational calculus; Conjunctive queries, equivalence and containment of conjunctive queries, query processing and optimization; Datalog and recursion, datalog evaluation; Incomplete information, possible and certain answers; Information integration, query rewriting.

Course:	*Advanced Statistics*
ID:	BZ-
Authors:	Mario Fedrizzi
ECTS:	4
Classification:	

Description:	Enable students to understand the basic inference techniques and their applications in the management of quality. The syllabus includes: Inferences based on samples: Chebyshev's rule, the central limit theorem, estimation with confidence intervals, the t-statistic, one-sided and two-sided tests about a population mean; Comparing two population means and determining the sample size, testing the assumption of equal population variances, comparing two population proportions and determining the sample size, Multinomial experiments and contingency table analysis; Nonparametric methods: the sign test for small samples and for continuous measurements, the Wilcoxon test, tests for comparing medians; Simple linear regression: the least square approach, the coefficients of correlation and determination, using the model for prediction. Quality, processes and systems. Statistical control and control charts, charts for monitoring the mean and the variation.

Course:	*Advanced Algorithms*
ID:	BZ-
Authors:	J. Nievergelt
ECTS:	4
Classification:	
Description:	The discipline of algorithm design, analysis and implementation is vast, covering many different application areas, types of objects to be processed, requirements, design and analysis techniques. This course surveys the broad field of algorithm design and analysis, emphasizing basic concepts, techniques, and examples. The syllabus includes: Introduction and overview. Computational geometry. Graph algorithms and network optimization. Algorithm analysis techniques. Numerical algorithms. Linear programming. Approximation algorithms. Randomized algorithms. Online algorithms and competitive analysis.

3.3.7 Advanced Modules - UPM

Course:	*Biomedical Informatics*
ID:	UPM-BI
Authors:	Victor Maojo Garcia
ECTS:	3
Classification:	2.7.3, 2.7.5
Description:	The biomedical informatics tries to analyze the main problems of the medical practice and to look for the best solutions using information technology. In this area it is very important de data, information and knowledege management. This course gives an overview of the biomedical informatics, and it focus mainly on research aspects more than application development aspects.

Course:	*Natural Language Processing*
ID:	UPM-NLP
Authors:	Ana Garcia Serrano
ECTS:	6
Classification:	2.7.4, 3.1
Description:	This course covers the following issues: basic technologies, ontologies and knowledge representations; knowledge recovery; information agents for the semantic web; and automatic translation.

Course:	*Intelligent Agents and Multiagents systems*
ID:	UPM-MAS
Authors:	Ana Garcia Serrano
ECTS:	6
Classification:	3.4, 3.5
Description:	The first goal of this course is to present theorical aspects and the current state of the technology used for design and develop intelligent agents. The second goal is related to the differents forms of distribution and coordination which are used in multiagents systems. And the third goal is to present some applications on the area of agents and multiagents systems.

Course:	*Grid Computing*
ID:	UPM-Grid
Authors:	Asuncion Gomez-Perez, Maria de los Santos Perez Hernandez, Pilar Herrero
ECTS:	3

Classification:	3.6
Description:	The grid technology facilitates the resolution of problems too costly with respect to the computation and the management. The main advantages of the grid computing are the following one: unlimited power due to many computers on-line working together, and elimination of the bottleneck of some processes

Course:	*e-Commerce*
ID:	UPM-e-comm
Authors:	Jose Luis Mate Hernandez
ECTS:	4.5
Classification:	Unknown
Description:	This course provides an overview of the e-commerce model on the web. The course is also focused on the market situation, real examples, and tools using in e-commerce.

Course:	*Design of Web Applications*
ID:	UPM-WebApp
Authors:	Francisco M. Sanchez Moreno
ECTS:	6
Classification:	Unknown
Description:	The course is focused on instalation and configuration of web servers, language for publishing in the web, the web programming, XML/SOAP protocol, java servlets and applets, and e-commerce.

3.3.8 Advanced Modules - UniTn

Description: At the Università di Trento a rearrangement of the courses is planned for the academic year 2006-2007. In this rearrangement, a new set of courses will be offered that will focus on Web Technologies, with a strong emphasis on the Semantic Web. At present it is impossible to indicate precisely the courses that will be offered, as they are being presently decided. An indication can however be given: it will be possible for students to take an advanced module concerning mainly Semantic Web Services and Ontology mapping.

3.3.9 Advanced Modules - VU

Web intelligence & Information SciencE (WISE)
Keywords: ontology engineering, applications, distributed artificial intelligence

Description: The intelligent Semantic Web techniques from the basic courses are applied in practical situations. This includes ontology engineering and innovative Semantic Web applications where amongst others a small but real Semantic Web application will be implemented. Furthermore the Semantic Web basics are extended by related techniques like distributed reasoning (e.g. with multi-agent systems) which to the nature of Web and Semantic Web.

Structure: This 36 ECTS advanced module is comprised of 6 courses and one seminar. The ECTS credit points vary from 3 to 7 depending on the course.

Course:	*E-Business Innovation*
ID:	VU-BI
Authors:	dr. ing. J. Gordijn, drs. E. Schulten, prof. dr. J.M. Akkermans
ECTS:	7
Classification:	1.3.4, 2.0.1, 2.0.2
Description:	The aim of this course is to understand and systematically analyze the multi-disciplinary aspects (strategy, business processes, technology issues, implementation) involved in innovations with information and communication technologies (ICT) in networked businesses. We will discuss theories and practical experiences, from different disciplines and industry sectors, covering some important recent topics in electronic business: formulation of strategy ;design and evaluation of e-business models; organizational readiness; future and perspectives of electronic business. Key topics will be exercised by small classroom workshops as part of an e-business strategy and implementation project to be carried out by the students.

Course:	*Qualitative Research Methods for the Information Sciences*
ID:	VU-RM
Authors:	prof. dr. J.M. Akkermans (contact), dr. ing. J. Gordijn
ECTS:	3
Classification:	UNKNOWN

Description:	This course helps prepare students who want to embark on their (Master) research. The course provides an overview and assessment of different scientific research methods, needed in a multi-disciplinary approach to Information Systems and how they function in an organizational context. Major topics are: • developing the research questions you want to answer; • planning your research; • qualitative research methods (e.g. interview, case study, action research, ethnography); • quantitative research methods (e.g. survey, questionnaire, statistical data analysis); • IS research methods (e.g. modelling, prototyping, simulation, scenario analysis); • aspects of theory formation; • how do you (and others) know that your research results are valid?; • research report writing.

Course:	*Ontology Engineering*
ID:	VU-OE
Authors:	prof. dr. A.T. Schreiber
ECTS:	3
Classification:	1.0.1, 1.0.2, 1.0.3, 1.0.5, 1.0.7, 2.3.2
Description:	Ontologies are nowadays used in computer science a means to share common concepts between information systems. This course is focused on theory, methods, and tools for constructing and/or extending ontologies for this purpose. Teaching subjects typically center around engineering principles, e.g. for subtype hierarchies (backbone identification, viewpoints, dimensions, constraint specification), part-of structures (types of part-of relations, representation of part-of relations), and default knowledge. Also, the mapping and/or integration of different ontologies is discussed. The course contains examples of how ontologies are used in practice. The assignments focus on real-life examples of ontologies currently in use in web applications.

Course:	*Intelligent Web Applications*
ID:	VU-IWA
Authors:	prof. dr. F.A.H. van Harmelen, A. Hess, R. Siebes
ECTS:	8
Classification:	1.1.1.2, 1.1.3, 1.3.2, 1.3.6, 2.0.1, 2.0.2
Description:	The World-Wide Web today is a huge network of information resources which was built in order to broadcast information for human users. Consequently, most of the information on the Web is designed to be suitable for human consumption: The structuring principles are weak, many different kinds of information co-exist, and most of the information is represented as free text. With the increasing size of the web and the availability of new technologies such as mobile applications or smart devices, there is a strong need for making the information on the World Wide Web accessible to computer programs which search, filter, convert, interpret, and summarize the information for the benefit of the user. The Semantic Web is a synonym for a World Wide Web whose accessibility is similar to a deductive database where programs can perform well-defined operations on well-defined data or even derive new information from existing data. This course addresses methods to create and use such a Semantic Web. It extends and complements the "Web-based Knowledge Representation" course by: I. deepening the understanding of the formal foundations of knowledge representation and reasoning on the web A) Semantics of web languages B) Reasoning in Semantic Web Languages II. investigating typical application scenarios concerned with the use of distributed and heterogeneous information on the web C) Information Extraction D) Information Integration E) Information Access

Course:	*Behaviour Dynamics*
ID:	VU-BD
Authors:	dr. C.M. Jonker, prof. dr. J. Treur

ECTS:	6
Classification:	UNKNOWN
Description:	This course teaches analysis and modeling of the dynamics of behaviour in Artificial, Biological, Cognitive and Social systems. Behavioural dynamics occurs in different forms, contexts and complexity. During the course examples of such behaviour are studied coming from software systems (e.g., knowledge- and agent-based systems), biology (e.g., functioning of the blood circulatory system, bacteries), cognition (e.g., the dynamics of beliefs, desires and intentions, emotions and feelings, complex reasoning tasks). The dynamics of behaviour of such systems is analysed (including verification and validation), modelled, and simulated in this course using dedicated techniques and tools.

Course:	*Organisational Dynamics*
ID:	VU-OD
Authors:	dr. M.C. Schut
ECTS:	6
Classification:	UNKNOWN
Description:	This course is on the simulation and analysis of organizations and their dynamics. In this respect, an organization is a social or computational structure for achieving controlled performance in pursuit of collective goals. We study the dynamics within existing organizations as well as the dynamics and evolution of organizational structure itself. Computational organization models specify the dynamics of information, personnel, decision responsibilities, tasks, and resources that are distributed geographically and temporally. We consider organizations as complex, dynamic, adaptive and evolving systems. A case study example of such a system, as discussed in the course, involves the traditional economic market. The analysis of organizational structure is explained from internal (managerial) as well as external (market) perspectives. Regarding the latter, evolution is discussed as a mechanism that drives organizational change from the outside. In the course, aspects of the courses on self organizing systems and organization theory are placed in the context of organization dynamics.

Course:	*Advanced Research Seminar*
ID:	VU-AS
Authors:	To be announced
ECTS:	6
Classification:	UNKNOWN

Description:	This seminar of 6 per year credits discusses recent and important research topics. The seminar has a loose form (workshop, reads/discussion group, intensive seminar over a few days) and have been set up in a way that it is interesting for our PhD - students (that such a seminar also can organize and teach). It can be also organized around the stay of a foreign guest research worker. The subject circulates in principle annually. At the same time this component can be exploited as experimental test field for new subjects which find afterwards their way in courses in the regular masters, so that this seminar has also a cousin function and spin-off for our regular education renewal.

3.3.10 Advanced Modules - UKarl

Course:	*Semantic Grid (Seminar)*
ID:	KA:SGR
Authors:	Sure, Studer
ECTS:	3
Classification:	3.6
Description:	The Semantic Web is seen as a means to enrich content on the web with machine-processable semantics. However, until now, the Semantic Web mainly addresses methods and technologies for static information, in contrast to the often dynamic services. On the other hand grid technology addresses the flexible and coordinated sharing of resources in dynamic groups of individuals or organizations. Typical problems are security aspects, retrieval and allocation of resources, as well as interoperability of services. As different applications use different data formats, this task is not trivial. In this seminar we will investigate how semantic technologies can help to overcome these problems. This includes application scenarios from automobile industry, biotechnology, and nature sciences. The course will be held in German.

Course:	*Semantic Technologies (Seminar) (Semantische Technologien: Methoden und Anwendungen))*
ID:	KA:STE
Authors:	Sure, Studer
ECTS:	3
Classification:	3
Description:	The Semantic Web is a very active field of research. Goal of this seminar is to cover up-to-date research questions. The details will only be fixed shortly before the course starts. The course will be held in German.

Course:	*Knowledge Portals (Seminar)*
ID:	KA:KPO
Authors:	Sure, Studer
ECTS:	4.5
Classification:	1.3.7, 2.7.1

Description:	Goal of this seminar is to examine knowledge management approaches to efficiently represent large amounts of knowledge as found in big enterprises or organizations. The participants will develop their own knowledge portals based on existing application servers such as ZOPE or JBOSS. These portals will be presented and evaluated towards the end of the course. The course will be held in German.

Course:	*Knowledge Discovery (Seminar)*
ID:	KA:KDS
Authors:	Sure, Studer
ECTS:	4.5
Classification:	1.3.2, 1.3.6
Description:	This seminar focuses on deploying techniques learnt in the corresponding course. The participants will apply machine learning methods to identify relevant information from large data repositories. This includes the implementation in Java and an experimental evaluation. The results will be presented and discussed towards the end of the course. The course will be held in German.

Course:	*Intelligent Systems in Finance (Intelligente Systeme im Finance)*
ID:	KA:ISF
Authors:	Seese
ECTS:	4.5
Classification:	1.3.6, 2.7.6, 3.5
Description:	A new generation of methods, generally called intelligent systems, are currently applied for various business and financial modeling tasks; and often outperform classical statistical approaches. The goal of this course is to give a well-founded introduction into these methods. This includes intelligent software agents, genetic algorithms, neural networks, fuzzy logic, expert systems, case-based reasoning and intelligent hybrid-systems. The application will focus on the financial domain such as for risk-management, stock quote analysis, portfolio management, and economic modeling. The course will be held in German.

Course:	*Management of Computer Science Projects (Management von Informatikprojekten)*
ID:	KA:MCP
Authors:	Stucky, Schätzle
ECTS:	4.5

Classification:	UNKNOWN
Description:	This course will cover the conditions, influencing factors, and methods for planning, deployment, and controlling of computer science projects. The following topics will be included: project environment and structure, expense estimation, project infrastructure and controlling, decision processes, negotiation, and time management. The course will be held in German.

Chapter 4

Summary and Discussion

by VU

The curriculum for the "European Academy for Semantic web Education (EASE)" proposed in this deliverable aims to qualify experts in the Semantic Web area. It should attract students with a bachelor degree in computer science, artificial intelligence or related area to study at two different European centers in Semantic Web. The curriculum finishes with a shared master degree implying the master of two EASE partners.

The curriculum consists of three main parts. The first part, the basic modules, covers the key concepts and the base for the Semantic Web technology. The basic modules define the basic material which will be taught by every partner in EASE. In the second part, the advance modules, the student goes to another partner in EASE and learn more about their specific research skills. Advanced modules can vary and are specific for each partner. They ensure that students will be qualified close to the border line of research. The curriculum concludes (obviously) with the master project as the last third part.

The flexible structure with its agreement on minimal ECTS credit points provides the necessary flexibility to integrate the parts of the existing master programs from different participating partners. Furthermore it allows to integrate other potential partners with interests in participating in EASE.

However, it should be noted that this curriculum should be considered as a starting point. First many leading partners in the shared master initiative are currently involved in a restructuring of the whole master programs. Therefore they were not be able to specify the detailed program for this curriculum at this point in time. But this curriculum should serve as a specification of requirements which must be considered during the design of their future master programs. Second for a Erasmus Mundus application it is the agreed opinion of each partner that a stronger structure is needed. But due to the restructuring of the master programs of many participating partners a stronger curriculum can not be defined at this moment.

The partners decided to start EASE on the base of this curriculum and will try to attract students from their home countries, Europe and outside of Europe to participate in the

“European Academy for Semantic web Education (EASE)”. EASE enforces that

the best students will study with the best experts in Semantic Web.