# 1. Overview of the Department

## 1.1 Research

The research at the Department for Computer and Information Science, IDA for short, is carried out in five divisions covering a broad spectrum of areas, several of which are multi-disciplinary. There is research in traditional computer science areas such as programming and specification languages, software engineering, databases and knowledge based systems, real-time systems, hardware design and verification, intelligent autonomous agents and theoretical computer science. But the department also hosts research in economic information systems, information systems for businesses and other organizations and human/cognitive aspects of computer systems, e.g. natural language processing and human-computer interaction.

The Department of Computer and Information Science, IDA, was formed in 1983 as an independent department. Since then it has grown to be one of the largest CIS-departments in Scandinavia, with several internationally well-known and recognized research groups. Several educational programmes with a large number of courses have been developed for undergraduate and graduate education.

The department has about 220 employees, with a staff of teachers and researchers of about 85 persons and administrative and technical staff of about 35 persons. There are 14 full professors in the department, ten consulting professors from outside the university and about 150 doctoral active students, about half of them employed in the department and the rest being industry doctoral students or employed at university colleges elsewhere.

IDA's research program has been designed to cover areas of strategic importance, both for undergraduate education as well as for the needs of society. Research in the department is organized and carried out in five divisions covering a broad spectrum of areas; several of which are multi-disciplinary. Each division is characterized by its long-term commitment to develop and maintain the knowledge within a defined area, and by its long term responsibility for individual graduate students. Within divisions there are a number of research laboratories and some smaller groups. Below, the research labs are listed by division. Each research lab have it's own web page, where full information about the lab is given.

*The Division for Databases and Information Technique (ADIT)*

- Engineering Databases and Systems (EDSLAB)
- Intelligent Information Systems (IISLAB)

*The Division for Artificial Intelligence and Integrated Computer Systems (AIICS)*

- Knowledge Processing (KPLAB)

*The Division for Human-Centered Systems (HCS)*

- Cognitive Systems Engineering (CSELAB)
- People, Computers and Work (MDA)
- Natural Language Processing (NLPLAB)

*The Division for Information Systems and Management (ISM)*

- Economic Information Systems (EIS)
- Information Systems and Work Contexts (VITS)

*The Division for Software and Systems (SaS)*

- Embedded Systems (ESLAB)
- Programming Environments (PELAB)
- Real Time Systems (RTSLAB)
- Theoretical Computer Science (TCSLAB)

## 1.2 Overview of divisions and research laboratories

The department hosts research in areas such as programming and specification languages, software engineering, databases and knowledge based systems, real-time systems, hardware/ software co-design and verification, artificial intelligence, intelligent autonomous agents, theoretical computer science, economic information systems, information systems for businesses and other organizations and human/cognitive aspects of computer systems, e.g natural language processing and human-computer interaction. A short review of the five divisions is given in this section.

### 1.2.1 ADIT - The Division for Database and Information Techniques

**Professor Nahid Shahmehri**

The Division for Database and Information Techniques (ADIT) conducts research on principles, algorithms, and methods for defining and constructing advanced tools for database and information management systems. Special emphasis is placed upon engineering information systems and applications for future information society and various user categories with different needs. The research topics include information security and privacy, peer-to-peer computing, mobile communication networks, multimedia databases, biological data banks, design of database systems for Internet & mobile applications, live help systems, user modeling, information extraction, context and content awareness, and agent technology.

Examples of ADIT's current research projects are inter-vehicular communication for traffic safety, e-services and security issues in intelligent homes, information technology for the elderly, dynamic e-service composition.

**EDSLAB - Laboratory of Engineering Databases and Systems**
Professor Nahid Shahmehri (acting lab leader)

EDSLAB conducts research on methods and theories for database support of engineering applications. Applications for this technology include mechanical, electronic, telecom, and software applications.

**IISLAB - Laboratory for Intelligent Information Systems**
Professor Nahid Shahmehri

IISLAB conducts research in intelligent information systems. Current projects focus on information security, information retrieval and filtering, and the representation, organization and processing of knowledge in distributed environments such as the World Wide Web.

### 1.2.2 AIICS - The Division for Artificial Intelligence and Integrated Computer Systems

**Professor Patrick Doherty**

The focus of interest for the Artificial Intelligence and Integrated Computer Systems Division is intelligent artifacts, that is, man-made physical systems containing computational equipment and software that provide them with capabilities for receiving and comprehending sensory data, for reasoning, and for performing rational action in their environment. Research and teaching activities in AIICS currently include topic areas in artificial intelligence (in particular knowledge representation), theoretical and applied logic, and computer science and programming. The AIICS division consists of one research laboratory and three additional research groups which are intended to grow into full-fledged research laboratories in the future.

**KPLAB - Knowledge Processing Laboratory**
Professor Patrick Doherty

Research in KPLAB focuses on the theoretical and practical aspects associated with the representation of knowledge and the reasoning techniques associated with the processing of knowledge as used by both physical and software artifacts. Current activities include the development of non monotonic temporal logics for reasoning about action, change and process; the development of logically-based knowledge representation frameworks for reasoning about and representing incomplete, uncertain, or vague information; the specification and implementation of higher-level cognitive tasks such as planning, prediction, explanation, diagnosis and execution monitoring; and the design and specification of deliberative/reactive architectures used in the implementation of autonomous artifacts such as robots and softbots. Special emphasis is currently being placed on the design and development of command and control architectures for unmanned aerial vehicles (UAVs) and their integration with active vision systems and other sensors. Such systems require on-line planners, prediction and chronicle recognition mechanisms, GIS and soft real-time databases, and a variety of knowledge representation frameworks with associated inference mechanisms used to dynamically construct and reason about the UAVs internal and external environment. As a new avenue of investigation, we are also pursuing the development of knowledge representation techniques for the semantic web.

**Other research groups in the AIICS Division:**

*SCML - The Soft Computing and Machine Learning Group*

Professor Patrick Doherty and Professor Andrzej Skowron

The focus of interest for this group is in the area of approximate reasoning and machine learning techniques. Currently, specific topics being pursued are rough set theory and its application, neural network research and technology, and machine learning and classification techniques based on the use, both individually and combined of rough sets and neural nets. Target applications are in the areas of bioinformatics, sensor fusion and data mining. The SCML group has a strong affiliation with the Group of Logic at the Institute of Mathematics, Warsaw University. Professor Andrzej Skowron leads this group.

*CASL - Cognitive Autonomous Systems Group*

Professor Erik Sandewall

Cognitive Autonomous Systems are high-level robotic systems in a broad sense of ’robotic’: they are computer systems that have the following capabilities: (1) autonomy - they are capable of operating with goals and with plans for achieving those goals, and of executing such plans in a robust fashion. (2) modelling- the ability to represent knowledge about their environment and about themselves. (3) perception - the ability to perceive phenomena in their environment, and to model them. (4) deliberation - the ability to reason about phenomena within the modelling range of expressivity in the system. (5) communication - the ability to receive information from other similar systems or from people, and to communicate it to them. We use the term ’cognitive’ as an umbrella term for the last four items in the list. Research interests in this group focus on selected aspects of the theory and software technology for cognitive autonomous systems according to the definition above.

*EIT - Education in Information Technology Group*

Associate Professor Anders Haraldsson

This is currently a support group for experimentation with new pedagogic techniques and tools for undergraduate and graduate courses taught within the AIICS division. Research interests focus on the use of information technology for support of courses in computer science and artificial intelligence. Tools are developed for the traditional deployment of courses and support of information flow in addition to deployment and support of courses on the WWW.

### 1.2.3 HCS - The Division for Human-Centered Systems

**Professor Lars Ahrenberg**

Research in the Division for Human-Centered Systems is aimed at studying and improving the interactions among humans, computing systems, and information resources. Human abilities constitute the goal as well as a point of departure for our research.

The research is concerned with the development of new technologies and methods as well as the effects of new technologies for individuals, groups and society at large. Thus, research is usually multi-disciplinary, combining methods from computer and information science with perspectives from the humanities and social sciences.

**CSELAB – Cognitive Systems Laboratory**
Professor Erik Hollnagel

Cognitive Systems Engineering is concerned with the study, analysis, modelling and design of systems of humans and machines together in ensembles. It is not about machines alone and not about humans alone but rather about what they do together.

**MDA – People Computers and Work**
Professor Toomas Timpka

The MDA group develops and studies information systems in working-life contexts, with a focus on applications in service organizations. The research has an interdisciplinary character and integrates methods from computer science, psychology and sociology. Specific areas of interest include computer-supported cooperative work, inter-organizational networks, economic evaluations of information systems and participatory design.

**NLPLAB – Natural Language Processing Laboratory**
Professor Lars Ahrenberg

NLPLAB studies linguistic processing and knowledge representation from linguistic, computational and behavioural perspectives. Current applied projects concern spoken and multimodal natural-language dialogue systems and computer-aided translation.

**Other research groups in the HCS Division:**

*ASLAB - Application Systems (Professor Sture Hägglund)*

The research in ASLAB, is conducted in groups working with Human-Computer Interaction, especially usability-oriented methods for IT design and Home Communication, and Web Software Engineering, with a special emphasis on knowledge acquisition tools and advanced web programming support.

*LIBLAB - Laboratory for Library and Information Science (Prof. Sture Hägglund)*

Research at LIBLAB, is focused on long term studies of the interactions between information technology and the generation, access to and use of information resources, in particular documents and document collections.

*GIS - Geographical Information Systems (Dr. Åke Sivertun)*

Research in the GIS group is applications of geographical information systems and with algorithms for spatial data processing.

### 1.2.4 ISM - The Division for Information Systems and Management

**Professor Birger Rapp**

ISM conducts research about management issues arising from the use of modern ICT, including the impact on organisations and business, communication, knowledge development and utilisation, business oriented model- and system development, and strategic and economic management control, accounting, auditing, design of control and responsibilities applied to information usage for information provision. Research is often conducted in co-operation with industry to achieve applicable solutions to business and organisational issues. Mutual research interests for the collaborating research groups are also encouraged and supported. ISM has responsibility for courses within the areas of model building and system development, information systems and

business management, and economic thinking applied to business and organisational use of information.

**EIS - Economic Information Systems**
Prof. Birger Rapp

The research area of Economic Information Systems involves, among other things, communication and transfer of information between people, as well as the development of suitable information systems for this purpose. This subject also deals with the use of modern information technology and the development of structures within organizations, together with the effects of information technology on people and organizations. This involves both questions concerning economic direction and control, and the capacity of people to take in and use information as well as training.

The division of Economic Information Systems conduct research in the following main streams:

Business Information Development; Application of Transaction and Principal Agent Theory; IT and New Organizational Structures; Simulation, Decision Support System and Control Systems of Manufacturing Flows; Business Control; IT-Economics; Internal Auditing; External Accounting and Auditing; Economic Crime Prevention; E-Business; Knowledge Management.

**VITS – Development of information systems and work contexts.**
Prof. Göran Goldkuhl

Research areas covered by VITS include business processes and information systems; inter-organisational relationships and electronic commerce; IT support for transportation, travelling and tourism; information systems - design & architecture; CASE/method tools; knowledge and method management. The research is mainly based on communicative and action theories and has a strong emphasis on methods for business and information systems development. Research approaches are mainly qualitative and case study based. VITS is a network research group with 30 researchers from the universities of Linköping, Borås, Dalarna (Borlänge), Jönköping, Karlstad and Örebro.

### 1.2.5 SAS – The Division for Software and Systems

**Professor Zebo Peng**

The division for Software and Systems (SaS) deals with research and education in the areas of software engineering, programming environments, systems software, embedded hardware/software systems, computer systems engineering, real-time systems and theoretical computer science.

The division has approximately 35 Ph.D. students involved in three postgraduate study programs: computer systems, computer science and engineering information systems. The research is funded from Linköping School of Engineering and receives also significant external funding from VR, VINNOVA, the Foundation for Strategic Research (SSF), KK-stiftelsen and the European Commission. The research covers both basic research and projects in cooperation with industry, for instance ABB Robotics, ABB Industrial Systems, Ericsson Radio Systems,

Ericsson Telecom, SKF, Saab, Saab Bofors Dynamics, Saab Combitech and several other companies. The research is carried out in four research laboratories:

**ESLAB – Embedded Systems Laboratory**
Prof. Zebo Peng

ESLAB conducts research on the design and test of embedded systems, especially those consisting of interacting hardware and software components. Special emphasis is placed upon the development of methods and tools for specification, modeling, synthesis, simulation, design for test, formal verification and hardware/software co-design. We are also concerned with the exploitation of systematic design and design automation techniques for industrial application areas, such as telecommunication, automotive electronics and aerospace.

**PELAB – Programming Environments Laboratory**
Prof. Peter Fritzson

Software engineering tools and architectures, programming languages and environments, including compilers, debuggers, testing tools, parallel and real-time programming tools; software engineering methodology and process improvement.

**RTSLAB – Laboratory for Real-Time Systems**
Doc. Simin Nadjm-Tehrani

Systems engineering, safety-critical systems, network survivability, fault-tolerance in distributed systems, real-time and embedded databases, resource allocation and quality of service guarantees.

**TCSLAB – Theoretical Computer Science**
Doc. Ulf Nilsson

Programming theory, declarative programming and specification languages, formal models and methods, algorithms and complexity.

# 2. Graduate studies in Computer and Information Science

## 2.1 General information

Graduate studies at the department consists of courses and project participation.The course programme is organized at the department level as *regular courses*, each of which is given approximately every second or third year (if possible), and *occasional courses* which depend on the profile and interests of current faculty and visiting scientists. The programme covers the areas: Computer Science, Computer Systems, Information Systems and Media, Economic Information Systems, Computational Linguistics, Cognitive Systems, Engineering Information Systems and Information Systems Development.

The department also hosts a National Graduate School in Computer Science, CUGS, with participation from Örebro University, Mälardalen University, Skövde University, Jönköping University and others. This school gradually started its operation during the academic year 2000-2001. In addition, research groups and doctoral students participate in other national graduate schools, for instance in Language Technology and in the area of Management and Information Technology.

The department also participates in several other special graduate schools aiming for interdisciplinary studies preparing also for a career outside the university, with funding from the Foundation for Strategic Research. ECSEL, Excellence Center in Computer Science and Systems Engineering, started in 1996 in cooperation with primarily the Department of Electrical Engineering. HMI, Human Machine Interaction, started in 1997 and its goal is to improve Swedish competence by educating specialists in HMI. It is a cooperation between Linköping (IDA, IKP, Tema-K) and Stockholm (NADA, DSV). IMIE, International Graduate School of Management and Industrial Engineering, has been in operation for some years with contributions from the subject area Economic Information Systems in our department. Graduate students in these schools belong to research groups in the home department, but follow a special study programme.

A special study programme for industry-based graduate students is available in the area of Applied IT and Software Engineering. This Industry Research School is funded by the Foundation for Knowledge and Competence Development and by participating companies.

About 150 Ph.D. students participate in the graduate programme, and may choose among about 30 courses given each year. The courses and seminars are normally given in English (unless all participants are fluent in Swedish).

The programme leads to one of the following degrees:

*Licentiate of technology or philosophy.* The requirements include 40 points (one point equivalent to one week full time studies) of completed courses and 40 points thesis work.

*Doctor of technology or philosophy.* The requirements are generally 80 points courses and 80 points thesis work. Most of the Ph.D. students take the licentiate degree as an integral part of their doctoral studies.

For the degree in technology, a master of engineering (4.5 years of study) is normally assumed as a prerequisite.

As an executive, there is one director of graduate studies (Ulf Nilsson). However, most of the administration and organization rests upon the director of graduate studies administration (Lillemor Wallgren). Most graduate students are employed by the department full time. They assist in undergraduate courses and other internal assignments of the divisions/laboratories, up to about 20% of their time. The rest of the time is spent on graduate courses and thesis project.

## 2.2 The Graduate Studies Programme Spring 2002

The presentation in later sections contains the following types of courses:

- General graduate courses offered for students of the whole department
- Graduate courses offered mainly for students within a division/research group or graduate school

In addition to the graduate study courses given in the Department of Computer Science, graduate students may also take courses from other departments, in particular courses from the special graduate schools CUGS, ECSEL, HMI, IMIE).

**Main seminar series and seminars in the divisions.**

The seminars are announced by e-mail, and occasionally by special announcement. They are strongly recommended for graduate students, and although the do not automatically give credit points in graduate studies, they are a necessary ingredient in the PhD training.

## 2.3 Contact for graduate studies information

Further information concerning the contents of this program can be obtained from Lillemor Wallgren, phone 013- 28 14 80, Ulf Nilsson, 013-28 19 35, Britt-Inger Karlsson, 013-28 17 06 or for a particular course from the person responsible for that course.

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