



Institute of Computer Science
Academy of Sciences of the Czech Republic

Papers for External Evaluation

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I Institutional Research Plan

1 Title and identification code of the research plan

Research Plan Title: *Challenges in Computer Science: Models, Algorithms and Applications*

CEZ code: *A06/98:Z1-030-9-ii*

Classification: *BD, BB, BC*

2 Title, identification number and type of research institution

Institution Title: *Institute of Computer Science, (ICS)*

Academy of Sciences of the Czech Republic, (AS CR)

Institution identification number (IČO): *67985807*

Institution Type: *K*

3 Manager of the research plan

Wiedermann, Jiří, Doc., RNDr., DrSc.

4 Duration of the research plan

1999 - 2003

5 Objectives of research

Annotation:

The long-term mission of the institute is to perform frontier research in computer science and transfer the respective new knowledge to society in general and to scientific community, students and application areas in particular. ICS currently conducts basic research in mathematical and logical foundations of computer science, and in scientific computing and mathematical modeling. It also performs interdisciplinary research in neurocomputing and complex processes modeling, and in medical informatics. The focus is both on new approaches to computing (such as nature-inspired ones) and reasoning, on their creative applications and on strengthening of existing classical methods. Applications are sought primarily in fields of biology, medicine and health care, earth sciences, economy, banking, environmental protection, etc. The ultimate strategic goal is the transformation of the institute into a renowned research center of excellence in computer science.

Key words:

Complexity theory, fuzzy logic, probabilistic methods, neurocomputing, scientific computing, mathematical modeling, modeling of complex systems, medical informatics.

6 Institutional Research Plan

6.a) Objectives

The Institute of Computer Science is a basic research institute whose mission is twofold:

- To perform *frontier research* in computer science
- To *transfer* the respective knowledge to society or, more specifically, to scientific community, to students, and to application domains.

Here, when speaking about frontier research we mean a research that fully corresponds to and/or co-determines world trends in development and applications of computer science.

As far as the institute's long-term research intentions are concerned they are necessarily focused to certain specific domains. These are chosen for their fundamental importance and their compatibility with the strength of the institute staff.

Having the previous in mind the institute's research objectives are split into two basic and two interdisciplinary research streams:

Basic research streams:

- Mathematical and logical foundations of computer science
- Scientific computing and mathematical modeling

Interdisciplinary research streams:

- Neurocomputing and modeling of complex processes
- Medical informatics.

Closely related to the above are activities related to the transfer and dissemination of the respective knowledge and experience to the society, in the widest sense of this word. These activities include:

- Application of the research know-how for the benefits of emerging information society, especially in selected interdisciplinary areas, such as health care and services, environmental protection, biomechanics, geomechanics, geodynamics, business, industry, etc.
- Active participation in Ph.D. education in the above mentioned research fields.
- International cooperation, organization of scientific events and scientific mobility.

In its research scope the general common denominator of institute's research intentions is the investigation, development and application of those computing paradigms, which can lead to a new quality in using the current and future emerging computing technologies. Simultaneously, the ICS aims at the transfer of the respective knowledge into the theory and practice of computing and at the speed-up of this process. Last but not least, the institute's ambition is also to transfer its know-how into university education. In this way the currently prevailing philosophy, theory and practice of computing will be pushed onto a new, qualitatively higher level. To do so, the present knowledge in various fields of mathematics and computer science must be re-evaluated from this particular viewpoint, and related and new relevant problems must be identified, investigated and solved.

In the sequel we will discuss each of above-mentioned gross research agenda in more details.

6.b) Background

For the first time in the history of science, we now collectively have substantial experience with standard large scale computing, and, more significantly, have had a few decades to reflect on its principles, possibilities and limitations. Along with this experience we also have a substantial body of the respective theory. Both our experience and the respective theory point to the fact that we have probably achieved the inherent limits of the prevailing — traditional — ideas and ways of computing. The traditional thinking about computing goes back to Turing and von Neumann and can be characterized by precision, rigor, certainty at the level of reasoning about computing, and by its deterministic, mostly sequential, realization. Recent results and trends, especially in logic and related areas of complexity theory, and practical experience from parallel and/or large scale computing clearly reveal the drawback of such approach in all areas where human-like style in problem solution is required, or where problems of large magnitude are solved. Therefore, new ideas, new computational paradigms are needed in order to push the computing onto a qualitatively higher level.

It appears that it is now when we may have an unprecedented opportunity to make progress along these lines. In different areas of computer science the magnitude of this opportunity, as well as ways of its realization, are different.

Below we will give the background and research objectives separately for each of the two basic research streams mentioned in the previous gross objectives and separately for the interdisciplinary research in neurocomputing and modeling of complex systems, and medical informatics.

Mathematical and Logical Foundations of Computer Science

Undoubtedly the emergence of new computational paradigms presents the greatest challenge to the pure theory. It is especially logic and complexity theory that, both, thanks to their very nature possess the most vigorous and the most flexible formal tools, methods and methodologies to cope with such intellectual task. In fact, it is in these two fields at the border of mathematics and computer science where the signs announcing the advent of a new philosophy of computing are clearly to be recognized. Namely, the progressive research trends here are directly inspired by the ability of human mind to effectively employ modes of reasoning/learning or problem solving that are approximate rather than exact, by the emergence of collective phenomena from the individual activities, and by the ability of human brain to realize the underlying computations effectively, using parallelism, randomness and probabilism rather than sequential determinism, and by the robustness of the underlying computational processes and devices. These approaches are related to often mentioned notion of 'computing by nature' that stresses computational mechanisms based on neural, molecular, genetic, or quantum computational paradigms, and under different computational scenarios, such as interactive, co-operating, learning, cognitive, etc. Considerations along the previous lines are at the heart of the respective long-term research objectives of the ICS in the field of theoretical foundations of computer science:

Mathematical and logical fundamentals:

- systematic development of the theoretical basis of non-standard (i.e., approximate, nondeterministic or uncertain, etc.) reasoning, with a special regard to approaches to fuzzy logic, probabilistic and possibilistic logic and related approaches ;
- design of the respective calculi for uncertainty, imprecision and vagueness quantification and processing, studying and proving of their theoretical properties both from logical and algorithmic points of view;
- development of theoretical basis for qualitative improvements of the GUHA method for automated hypothesis generation, sophisticatedly incorporating the achievements in fuzzy logic and data mining.

Algorithmical fundamentals:

- design and investigation of models suitable for realization of formal calculi studied/proposed in the previous item;
- design and development of formal, abstract machine models embodying the ideas of new computing, with special regard to massively parallel models, distributed models, realistic models, and nature-inspired models;
- analysis of the computational power, efficiency and learning ability of models from the previous item, and also in-depth study of standard and restricted models of computing;
- investigating the relations among complexity classes of the respective models and traditional ones;
- design and analysis of efficient parallel, distributed and randomized algorithms for the fundamental problems in computing, as well as for various application areas, especially in the field of scientific computing;
- analysis, design, and development of formal methods and algorithms for the inconsistency, conflict resolution in the process of data/knowledge bases integration, including the problems of different kinds of the fuzziness (vagueness, degree of truth) and of the uncertainty (probabilistic, possibilistic, degree of belief).

Scientific Computing and Mathematical Modeling

Announcing a new computing era takes a special form in scientific computing. The main difference between scientific computing and '*computing per se*' seems to be that the former is confronted from the very beginning with the well-formulated tasks. Also, the search space for finding the respective algorithms is usually well known, represented in terms of mathematical spaces with known properties that should be exploited to design the algorithms efficient from some point of view. What makes the problems difficult are usually the sizes of problems to be solved, implying the need of fast algorithms, but still with the guaranty of their correct and precise solution. Also, there is an increasing need to model unprecedentedly large formal systems with a complex behavior, e.g. in biomechanics, geodynamics, environment pollution, etc. The problem of finding the proper mathematical model is an art in itself. Realization of the resulting model requires coupling of modern mathematical tools with advanced programming optimization techniques, carefully designed data structures, and appropriate programming models and tools, inclusively the presentation tools. Last but not least, suitable high

performance computing platforms are needed. Except of some simple cases, the mechanical exploitation of parallelism could lead to algorithms that do not give correct results due to the lost of stability of the underlying numerical processes, or the loss of precision of underlying computations. In the massively parallel environment, also problems related to the reliability of individual processors, transformed into fault tolerant algorithms, must be solved. Thus accepting new computational paradigms leads to problems specific to this kind of computations. This is reflected in the following research agenda in this particular field:

Numerical Algorithms:

- Design and analysis of new high performance numerical algorithms reflecting the new computational paradigms, stressing scalability, stability, fault tolerance, precision preservation and efficiency, especially in linear algebra, nonlinear prediction, numerical solution of partial differential equations, non-smooth analysis, large scale nonlinear programming, semi-infinite optimization and optimal control, variational inequalities, complementarity problems and problems with equilibrium constraints;
- Experimental realization and verification of proposed algorithms using advanced programming techniques, environments and high performance computers.

Mathematical Modeling:

- Analysis and computation of basic models of physical reality surrounding us which can be described by integro-differential equations;
- Approximations of problem solutions obtained through heavy use of different techniques ranging from data mining, development of new computational models via advanced numerical methods up to sophisticated graphic representation based on modern software engineering;
- Application of techniques of mathematical modeling to real-world problems with their specific conditions (e.g. in geodynamics, geomechanics, biomechanics and environmental protection).

Neurocomputing and Modeling of Complex Processes

Neural nets are one of the paramount examples of computing inspired by the real biological systems - viz. human brains. After a decade of storm development in eighties, mainly within the field of artificial intelligence, the respective research has established itself as a respectable discipline at the boarder between computer science and artificial intelligence. While the earlier research was characterized mainly by an enthusiastic experimental and empirical approach, the current approach stresses the use of formal models, their efficiency analysis, investigation of approximation abilities of the respective models and search for the classes of problems solvable by them. Closely related to neurocomputing are also other nature-inspired approaches to computing, such as genetic algorithms, evolutionary computing, molecular computing, quantum computing, etc., often in connection with so-called non-linear modeling of complex processes.

Modeling of complex processes is a wide scientific discipline where many approaches from different areas (mathematics, statistics, physics, economy etc.) are confronted with the aim of better understanding, identifying and modeling of complex data coming from various sources. The relationships among individual variables (e.g. time series) are intensively investigated using sophisticated data mining techniques including neural networks, genetic algorithms, rule-based systems, advanced statistical approaches (surrogate data tests, classification and regression trees, non-linearity detection tests), dynamical and chaotic systems etc.

The expected institute's efforts within this field are as follows:

Neurocomputing:

- Extending the theoretical basis of neural networks--based computation with a special regard to approximation theory and related development;
- Investigating new nature-inspired computational models such as genetic, evolutionary, molecular, cognitive computing, etc;
- Studying of approximative, learning and cognitive abilities and complexity of the respective models.

Modeling of complex processes:

- Building and extending the theoretical basis of identification, modeling and prediction of complex time series and data analysis;

- Studying the feasibility of the developed approaches in different areas, especially in medicine, environment and energy sectors;
- Designing decision support systems.

Medical Informatics

The novel trends in computing manifest themselves also by an increased stress to interdisciplinary approaches and in an ongoing search for new applications of information technologies in the important domains of society. Such approaches form the technological bases of the emerging information society. Along these lines, interdisciplinary medical informatics research is focused on a specific field of information science and technology within the field of medicine, health care and biomedical research. Thus, the respective research is also of an applied nature. The main streams in the research in medical informatics are health and clinical information management, computer-based patient records, information systems, image and signal processing, and knowledge processing and decision support systems. The corresponding interdisciplinary research at ICS focuses mainly to the following fields:

Information modeling in medicine and healthcare:

Different types of information are studied using information theory, statistical and artificial intelligence approaches. Biomedical concepts are examined and structured, their properties are generalized and the range of their usability is cleared up. A special focus is given to clinical, epidemiological and genetic information.

Research on computer-based patient records and information systems:

Computer-based patient records, especially structured multimedia electronic ones, are studied and their feasibility in clinical practice and healthcare is evaluated.

Knowledge processing and decision support systems in medicine and healthcare:

Decision support systems, including problems of extracting relevant information, are proposed and solved for concrete medical applications. Knowledge based systems, medical guidelines technology and probabilistic expert systems in medicine and health care are studied, especially in the field of cardiology.

Applications

The new or changing approach to computing as described above finds its way into practice only slowly. This is due to the relative novelty of the approach and conservatism of practice, which often relies on past, 'inherited' solutions. Therefore the important institute's mission is also to look for potential applications of solutions developed within the previous research streams and to support the penetration of the respective information technology into practice. Along these lines interdisciplinary approaches will become increasingly important. This determines the objectives that all aim toward practical use of institute's know-how:

General aims:

- identifying new application areas for institute's theoretical results, especially in the field of knowledge extraction, neural computing, scientific computing, mathematical and non-linear modeling, interface specification and component-based programming, and medical informatics;
- Experimental realizations of methods, algorithms and tools developed within the institute research program.

Applications in Concrete Domains:

- Pilot applications mostly in terms of program packages, expertise and introductory studies for selected results especially in biology, medicine, health care, biomechanics, geosciences, environmental modeling, banking, economy, energetics, etc.
- New applications and a further development of GUHA method and of related data mining methods.

Ph.D. Education

In order to support the transfer of Institute's research its active participation in Ph.D. education is a condition sine qua non. Along these lines, cooperation especially with Faculty of Mathematics and Physics, Charles University, Faculty of Nuclear Sciences and Physical Engineering, and Faculty of Electrical Engineering of the Czech Technical University should continue or should be extended. If possible and feasible a similar cooperation with regional universities should be established. In addition

to a welcomed opportunity for institute's key researches to submit their results to students' critical reviews this will also create a basis for attraction of students to scientific work within the ICS.

Cooperation and Dissemination of Results

The intensive and worldwide international cooperation with similar centers is important not only for the development of institute's scientific potential, but also for its firm establishing within the respective international research structures. Along these lines Institute's participation in international research programs is its first priority. Organization of scientific events and scientific mobility goes hand in hand with such efforts.

6.c) Methods and Equipment used

The above presented research plan forms a natural extension and/or continuation of previous institute's research efforts in which standard methods of scientific research have been used. Among them, especially the role of specialized seminars, workshops and conferences should be stressed. Active participation of institute's researchers in postgraduate education and their mobility among cooperating institutes form a vital component of their scientific development.

The computational equipment needed for the intended research program is the standard one that will be renewed as needed from institutional and grant funds. For computationally intensive applications remote supercomputing resources of cooperating Czech or foreign institutes will be used.

6.d) Research Plan Schedule

It goes without saying that within the long-term basic research planning, reviewed at the level of the whole institute, no firm schedule can be given. Only the main research intentions along particular research streams can be outlined as done in previous parts of this work.

As mentioned in the annotation in section 5, the ultimate strategic goal is to turn the ICS into a renowned research center in computer science, which would form the theoretical background for the emerging information technologies and could also serve as a partner for similar foreign centers. In order to achieve this goal the ICS should pass through three stages of development whose reaching can be predicted only in rough terms:

- Up to 1999: stabilization of ICS's scientific potential and profile
- 2000-2004: profiling of ICS's scientific schools in the principal domains of its research activities and transferring of knowledge to society;
- 2005 and above: towards maturity

Of course, there are numerous factors that will influence this process. Some of them are of a subjective nature, depending only on the Institute and on its efforts. These are subjects of the Institute's research agenda presented here. The Institute can influence the remaining ones, related mainly to the science-political and economical environment, only marginally. The crucial are the (related) questions of renewing the flow of young people to science and of establishing the relation between science and economy. One can hope that in that sense the future will develop positively.

6.e) Outstanding scientists involved and their research interests

Prof. RNDr. Miroslav Fiedler, DrSc.

- linear algebra; matrix theory; graph theory; Laplacian; positive definite matrix; M-matrices; Hankel matrices; Bézier polygons; acyclic matrices; doubly stochastic matrices; totally positive matrices

Prof. RNDr. Petr Hájek, DrSc.

- Classical logics; many-valued and fuzzy logics; softcomputing; foundations of computer science, artificial intelligence, data mining (GUHA)

RNDr. Ivan Kramosil, DrSc.

- Probability theory; alternative mathematical tools for uncertainty quantification and processing; artificial intelligence

RNDr. Věra Kůrková, DrSc.

- Mathematical theory of approximating ability and complexity of layered neural networks; problem of course of dimensionality.

Ing. Ladislav Lukšan, DrSc.

- Numerical analysis, nonsmooth analysis, large-scale nonlinear programming; numerical linear algebra

Doc. Ing. Jiří Nedoma, CSc.

- Mathematical modeling; numerical solution of partial differential equations

Mgr. Roman Neruda, CSc.

- Approximation of functions by neural networks; alternative learning algorithms; evolutionary computation; adaptive agents.

Doc. Ing. Mirko Novák, DrSc.

- Theory of system reliability; neural networks; predictions; applications in transportation sciences.

RNDr. Milan Paluš, CSc.

- Nonlinear dynamics and theory of deterministic chaos, information theory, time series analysis; nonlinearity explanation and detection in experimental data

RNDr. Ladislav Pecen, CSc.

- Medical informatics; statistical analysis; mathematical modeling

Ing. Emil Pelikán, CSc.

- Time series prediction; neural networks; data mining; application in economy; environment; power systems

Ing. Dr. Miroslav Rozložník

- Numerical linear algebra; iterative methods of linear algebra; analysis of algorithms in finite precision; applications to fluid flow and transport

RNDr. Petr Savický, CSc.

- Representation of Boolean functions; binary decision diagrams; decision trees; random Boolean formulas

Doc. Ing. Zdeněk Strakoš, CSc.

- Numerical linear algebra; computations in finite precision; iterative methods for linear algebraic systems

RNDr. Jiří Šíma, CSc.

- Complexity theory of neural network models: computational and descriptive power, learning and generalization complexity; neural and hybrid expert systems; efficient algorithms.

Ing. Václav Šebesta, DrSc.

- Application of neural networks in industry and medicine; the use of GUHA method for the markers determination; parallel computer architectures; auditing and assessment of quality systems in SW, HW and IT organizations.

Ing. Miroslav Tůma, CSc.

- Numerical linear algebra; direct and iterative methods for sparse matrices; preconditioning of iterative methods; parallel computing; applications to fluid flow and transport

Doc. RNDr. Jiří Wiedermann, DrSc.

- Complexity theory; machine models; neurocomputing; cognitive computing

Prof. RNDr. Jana Zvárová, DrSc.

- Medical informatics; decision support systems and knowledge modeling; stochastic models in clinics, genetics and epidemiology

Name	B	M	S	D	E	J	J/A	O	C	C/A	K	V	N	Total	I	Citations
Fiedler Miroslav		1				18				1				20		224
Hájek Petr	1	6			2	15		1	14	3	1	9		52	4	163
Kramosil Ivan						12			16	1		4		33		8
Kůrková Věra		2		1	1	6			16			7		33	1	102
Lukšan Ladislav			1			10			3	1	4	22		41		28
Nedoma Jiří	1					12			3	5	1	11		33	2	7
Neruda Roman	1			1					8	4		7		21	1	14
Novák Mirko	1					1		1	8	4	2	20		37	1	3
Paluš Milan		3				15			1	3		1		23	4	119
Pecen Ladislav						17	29	11	3	5	2	2		69	2	9
Pelikán Emil	1					6		1	12	6		7		33	1	10
Rozložník Miroslav				1		5		1	4	1		7		19		27
Savický Petr						8			9			6		23		21
Strakoš Zdeněk			1	1	1	6			3	2	3	6		23	4	75
Šebesta Václav	1					3	1	1	4	5	4	5	1	26	1	10
Šíma Jiří	1					7			5	1	1	6		21	1	45
Tůma Miroslav						7		1	9	1		16		34		66
Wiedermann Jiří				1	3	3			11			12		30	6	38
Zvárová Jana	1	6		1	1	18	7	13	22	18	1	2	18	108	6	39

Table 1: List of publications 1995–1999.

(B = monograph, M = chapter in book, S = textbook, D = dissertation, E = editorship, J = paper in international journal, J/A = abstract in a journal, O = paper in national journal, C = paper in proceedings of international conference, C/A = abstract in proceedings of international conference, K = paper in proceedings of national conferences, V = report, N = popular paper, I = invited paper)

II Results Related to the Research Plan

Below we will state annotated summaries of results related to the research plan from Part I and the most important relevant publications. This Part is structured according to the four streams presented in Part I.

1 Annotated summary of results

Mathematical and logical foundations

Most important results from this domain may be grouped as follows:

Mathematical fuzzy logic.

Fuzzy logic, in its narrow and mathematically precise sense, has been conceived as a formalized tool to quantify and process uncertainty in the sense of vagueness, fuzziness and lack of crispness. Basic fuzzy logic BL (in both propositional and predicate version) has been formulated as a logic based on continuous t-norms as semantics of conjunction and their residua as semantics of implication. The axiomatic system has been subjected to systematic investigation of completeness, computational complexity, generalized quantifiers, relation to modal logic and probability theory and other aspects. Particular famous logics (Lukasiewicz, Gödel, product logic) are extensions of BL. The results are contained in a monograph by P. Hájek and a series of subsequent papers and are being widely recognized as a new and adequate foundation for mathematical fuzzy logic. Several foreign authors have published papers on the logic BL, BL-algebras and related systems.

Alternative models and methods for uncertainty quantification and processing .

Possibilistic measures and theories, as well as belief functions in the sense of Dempster-Shafer theory, have been in massive development in the last ten years. Our contribution (a series of papers by Kramosil) concerns

- *probabilistic analysis of Dempster-Shafer theory* (belief functions over infinite spaces, belief functions with non-numerical and non-traditionally understood numerical values, approximation of belief functions in the case of partially defined compatibility relations and other results),
- *Boolean-like interpretation of possibilistic measures* (possibilistic measures with values in the unit interval of reals but under non-standard Boolean-like partial ordering and non-standard operations were proved to have the properties of classical probability measures).

Computational models and computational complexity.

The research comprises the design and analysis of various computational models, from traditional ones (automata, Turing machines, branching programs) to non-standard ones (parallel and distributed models, neural nets, genetic algorithms, learning, cognitive and interactive machines, networks of machines etc.). The main results can be divided into the following topics: general complexity theory, complexity of neural networks, branching programs, theory of neural expert systems and representation of Boolean functions. The most important “finished” result seems to be the *theory of neuromata*, which deals with finite neural networks seen as acceptors of formal languages (Wiedermann, Šíma). A formal model of *cogitoid* (Wiedermann), modeling algorithmic aspects of mind development, was designed and analyzed. Complexity of decision trees for Boolean functions was investigated (Savický and co-authors) and it was shown that the well-known quasipolynomial upper bound cannot be significantly improved. In 1995, J. Wiedermann was asked by the editor (Jan van Leeuwen) of a prestigious Volume 1000 of the Springer series Lecture Notes in Computer Science to contribute to this volume with an overview on the achievements in the field of parallel machine models.

The results contribute, each from its own point of view, to the emerging general understanding of computing, as sketched in Part I and to its theoretical foundations. In particular, they clarify the distinction between uncertainty (of knowledge, information, data) as fuzziness on the one hand and randomness and belief on the other; second, they apply the notions of the theory (theories) of computational complexity to non-standard computational models as neural networks and others.

Selected papers:

P. Hájek: *Metamathematics of Fuzzy Logic*. Trends in Logic vol. 4, Kluwer 1998, 308 pp., <http://www.wkap.nl/book.htm/0-7923-5238-6>, Hardbound, USD 130.00

This book presents a systematic treatment of deductive aspects and structures of fuzzy logic understood as many valued logic *sui generis*. Some important systems of real-valued propositional and predicate calculus are defined and investigated. The aim is to show that fuzzy logic as a logic of imprecise (vague) propositions does have well developed formal foundations and that most things usually named „fuzzy inference“ can be naturally understood as logical deduction.

There are two main groups of intended readers. First, logicians: they can see that fuzzy logic is indeed a branch of logic and may find several very interesting open problems. Second, equally important, researchers involved in fuzzy logic applications and soft computing. As a matter of fact, most of these are not professional logicians so that it can easily happen that an application, clever and successful as it may be, is presented in a way which is logically not entirely correct or may appear simple-minded. (Standard presentations of the logical aspects of fuzzy controllers are the most typical example.) This fact would not be very important if only the *bon ton* of logicians were harmed; but it is the opinion of the author (who is a mathematical logician) that a better understanding of the strictly logical basis of fuzzy logic (in the usual broad sense) is very useful for fuzzy logic appliers since if they know better what they are doing, they may hope to do it better. Still more than that: a better mutual understanding between (classical) logicians and researchers in fuzzy logic promises to lead to deeper cooperation and new results. Technically, algebraic structures called BL-algebras play an important role in proofs of completeness of investigated axiomatic systems. The book should play an unifying and foundational role, offering a new strong symbolic framework, presenting many scattered results and elaborating many new ones.

Contents: 1. Preliminaries, 2. Many-valued propositional calculi, 3. Lukasiewicz propositional logic, 4. Product logic, Gödel logic, 5. Many-valued predicate logics, 6. Complexity and undecidability, 7. On approximate inference, 8. Generalized quantifiers and modalities, 9. Miscellanea, 10. Historical remarks.

I. Kramosil: *Belief Functions Generated by Signed Measures*. Fuzzy Sets and Systems, Vol.92, 1997, No.2, pp.157-166. Held: International Conference on Fuzzy Sets Theory and Applications /3./ - Liptovský Sv. Ján, SK, 96.01.22-96.01.26

Dempster-Shafer theory in general, and the notion of belief function in particular, can be obtained by an application of classical Kolmogorov probability theory to set-valued random variables. Namely, the degree of belief ascribed to a set of solutions, answers, stated, hypotheses, etc. Is defined by the probability with which the set-valued random variable in question takes values within this set of solutions. This model enables to generalize the notion of belief function in a number of different directions: to infinite basic spaces, to approximations of belief functions in the case of incomplete data, and also to belief functions generated by more general set functions than probability measures, in particular, by general measures (with positive values greater than one) and by signed measures (admitting also negative and infinite values). The referred paper solves some mathematical problems arising in the process of such a generalization and can be also taken as an integral part of a more or less homogeneous collection of papers dealing with a systematic probabilistic analysis of Dempster-Shafer theory. At this level of formalization and systematical development, this approach is perhaps at the top level compared with the present research in the domain.

J. Wiedermann: *Quo Vadetis, Parallel Machine Models?* Computer Science Today. Recent Trends and Developments. (Ed.: van Leeuwen J.) - Berlin, Springer-Verlag 1995, pp.101-114

The starting point of this (invited) paper is the often cited popular claim that the practice of parallel computing seems to be in a crisis. The reason is that parallel computing has not become a common matter as it was expected some time ago. Some people are up in arms accusing computer science for not being sufficiently prepared for the advent of parallel computing and for not offering immediate remedies for the current situation. The paper recapitulates the developments within the corresponding field of computer science — namely in that part of complexity theory that deals with abstract parallel machine models. It explains the backgrounds, achievements and recent trends in this theory. A continuous interplay between the internal needs of the theory and the response to technological achievements is seen. The parallel computing crisis and possible ways to resolve it are explained. The conclusion is that the development within this field follows the usual way of searching for scientific

truth and there is nothing and nobody to be blamed for the current status quo in practice of parallel computing.

J. Šíma, J. Wiedermann: *Theory of neuromata*. Journal of the ACM, Vol. 45, No. 1, 1998, pp. 155-178.

Mathematical models of neural networks have world-widely been studied and exploited for computing in many artificial intelligence applications. The computational and descriptive power of neural networks is investigated by comparing their various architectures with each other and with more traditional models of computation and descriptive tools such as finite automata, regular expressions, grammars, Turing machines, Boolean circuits, etc. The aim of this approach is to find out what is, in principle or efficiently, computable by particular neural network models, and how to implement desired functions in an optimal way.

In the present work the descriptive complexity of finite discrete-time binary-state recurrent neural networks which recognize exactly regular languages is determined with respect to regular expressions. This includes a construction of the so-called neuromaton from a given regular expression which is proved to be size-optimal. Moreover, an example of regular language is shown whose description requires an expression of exponential length while the respective neuromaton recognizing this language consists of only linear number of units. This illustrates the great descriptiveness of neuromata exceeding that of regular expressions which is also confirmed by the proof that the emptiness problem for neuromata is PSPACE-complete. In addition, a subclass of regular languages — the so-called Hopfield languages — that are recognized by symmetric neuromata is introduced and fully characterized.

Jukna S., Razborov A., Savický P., Wegener I.: *On P versus $NP \cap coNP$ for decision trees and read-once branching programs*, to appear in Computational Complexity 8

Besides other things, the paper demonstrates a Boolean function with the following properties. Both the function and its negation are expressible by a polynomial size disjunctive normal form, or, equivalently, by a nondeterministic decision tree, however, every deterministic decision tree for the function is quasipolynomially large (an exponential from a squared logarithm). This proves that a well-known quasipolynomial upper bound on the size of such a decision tree cannot be significantly improved. Moreover, new examples of functions with analogous properties w.r.t. deterministic and nondeterministic read-once branching programs are presented.

Scientific computing and mathematical modeling

Numerical methods for large-scale optimization and nonlinear programming

First, hybrid trust region methods for large sparse nonlinear least squares were developed, which improve the efficiency of Newton and Gauss-Newton type methods. These methods were also adapted to optimization of dynamical systems. Secondly, efficient methods for large sparse systems of nonlinear equations based on the preconditioned CGS subalgorithm were developed together with proving their global convergence properties. These methods were implemented in the UFO system. Third, a fully iterative indefinitely preconditioned algorithm for large sparse equality constrained nonlinear programming problems was developed. Moreover, surprising properties of this indefinite preconditioner was proved and a connection with null-space methods was shown (L. Lukšan, J. Vlček).

Numerical methods for nonsmooth analysis and optimization

First, a bundle-Newton second-order method was developed together with proving its global and superlinear convergence properties. This method was successfully applied to solving Hemivariational inequalities. Furthermore, two very efficient variable metric methods for convex and nonconvex nonsmooth optimization were developed. These new methods are based on null steps, which serve for obtaining necessary information about a nonsmooth function, on a simple aggregation and on a special estimation of linearization errors. Variable metric updates allow us to decrease the size of quadratic programming subproblems, which substantially decrease computational time. All methods were implemented in the UFO software system (L. Lukšan, J. Vlček).

Validated computations and reliable computing

The main activity in this domain deals with problems of various types whose data are not known exactly but are given by intervals of real numbers (coming from imperfect measurements, rounding in preceding computations, representation in finite precision arithmetic etc.) (R. Rohn)

Results obtained concern (i) NP-hardness of determining exact bounds for values obtained from inexact data of similar problems, (ii) amount of over-estimation incurred by polynomial algorithms for solving such problems (and other topics).

Algorithms for Solving Large and Sparse Linear Systems

Numerical modeling of many real-world problems requires in its ultimate computational step efficient tools for finding solutions of large, generally sparse systems of linear equations.

Approximate inverse preconditioners were developed in order to mitigate the difficulties associated with the use of implicit preconditioners on vector and parallel computers. They are relatively easily parallelizable and therefore attractive for modern parallel computer architectures.

The AINV algorithm, developed in a series of joint papers with our collaborators is widely recognized as one of the most effective and robust approximate inverse techniques (Z. Strakoš, M. Rozložník, M. Tůma).

Theoretical questions of linear algebra, special matrices, numerical stability and rounding errors in iterative solvers

A considerable attention is devoted to solving some theoretical problems of linear algebra. We have solved some of the problems concerning special matrices which are extremely important both for the theory and applications (M. Fiedler).

Krylov space methods represent fundamental tools for numerical solution of problems involving very large sparse matrices. In this field, our group substantially contributed to solving questions concerning the stability of nonsymmetric Krylov space methods formulates in fact a program, which has been followed by the members of our group since then. It has led to several important and internationally recognized papers written by V. Pták, M. Rozložník and Z. Strakoš jointly with A. Greenbaum, A. Björck, T. Elfving, M. Arioli and M. Gutknecht.

Many results in this domain belong to the mainstream of numerical computations and theoretical linear algebra.

Selected papers:

L. Lukšan, J. Vlček: *Indefinitely preconditioned inexact Newton method for large sparse equality constrained nonlinear programming problems.* Numerical Linear Algebra with Applications 5 (1998) 219-247.

The paper contains a description of a new iterative method for solving large sparse equality constrained nonlinear programming problems. This method uses a fully iterative scheme based on the preconditioned conjugate gradient algorithm. The main result consists in discovering a new efficient indefinite preconditioner for saddle-point systems and proving its surprisingly excellent theoretical properties. This new preconditioning technique considerably decreases the number of inner iterations which are required for solving linearized subproblem so that it outperforms direct solvers.

L. Lukšan, J. Vlček: *A bundle-Newton method for nonsmooth unconstrained minimization.* Mathematical Programming 83(1998) 373-391.

The paper contains a description of a new bundle-type method for general nonsmooth unconstrained optimization problems. This method uses a quadratic approximation of the nonsmooth function based on the generalized Hessian matrices obtained from the bundle information. The new line-search strategy and the special aggregation technique allowed us to prove a global and superlinear convergence of the proposed method. This method was successfully used for solving hemivariational inequalities (M. Makela, M. Miettinen, L. Lukšan, J. Vlček, Journal of Global Optimization 14 (1999) 117-135). In this case, the number of iterations was 1000 times lower than the number required by the classical proximal bundle method.

A. Björck, T. Elfving, Z. Strakoš: *Stability of conjugate gradient and Lanczos methods for linear least squares problems.* SIAM J. Matrix Analysis and Applications 19 (1998) 720-738.

The conjugate gradient method applied to the normal equations (CGLS) is often used for solving large sparse linear least squares problems. The mathematically equivalent algorithm LSQR based on the Lanczos bidiagonalization process is an often recommended alternative. In the paper, the achievable accuracy of different conjugate gradients and Lanczos methods in finite precision is studied. It is shown that an implementation of CGLS in which the residual of the normal equations is recurred will not in general achieve accurate solutions. The same conclusion holds for the method based on Lanczos bidiagonalization with the standard starting vector. For the preferred implementation of CGLS we bound the error of the computed residual. Numerical tests are given that confirm a conjecture of backward stability. The achievable accuracy of LSQR is shown to be similar. The analysis essentially also covers the preconditioned case.

M. Benzi, M. Tůma: *A sparse approximate inverse preconditioner for nonsymmetric linear systems.* SIAM J. Scientific Computing, 19 (1998) 968-994.

The paper generalized new approach AINV to preconditioning for large, sparse linear systems which is advantageous especially when using modern computer architectures. Being devoted to nonsymmetric systems it has shown that the convergence rates of an underlying iterative method can be comparable with those obtained with standard implicit preconditioners. The paper, highly quoted since then, is an actual starting point of a series of our results concerning preconditioned iterative methods marked by solving systems with millions of variables in parallel with high speedups, efficient computation of very ill-conditioned linear systems or reaching high local processor efficiencies for preconditioned blocked iterative solvers.

M. Fiedler, T.L. Markham: *Consecutive column and row properties of matrices and the Loewner-neville factorization.* Linear Algebra and Applications 266 (1997) 243-259.

Motivated by the results from the theory of totally positive matrices, a theoretical basis for the factorization of matrices into a product of a certain-type of bidiagonal matrices is presented. Originality of this approach is that a commutativity of the basic field is not assumed. The continuation of this research led to two new papers by the same authors which generalize the results to the class of totally nonsingular matrices and to the class of generalized totally positive matrices.

Neurocomputing and modeling of complex processes

The Research Group *Mathematical Theory of Neural Networks* obtained important results in several areas.

First, for nonlinear approximation of neural network type, properties of projections operators (such as questions of their existence, uniqueness and continuity) have been described along with lower and upper bounds on approximation rates have been derived. Sets of multivariable functions that can be approximated by neural networks of various types with low complexity have also been described. These results have been used to derive estimates of complexity of networks with local and non-local units and for characterization of sets of functions that can be approximated by networks with "dimension-independent" complexity. Some constructive proof techniques have been used to design or simplify learning algorithms and to estimate speed of their convergence. On one hand, the respective results illustrate the way in which a mathematical formalization contributes to choice of neural network architecture. On the other hand, they show how practical motivations from the field of neurocomputing enrich mathematics by new concepts and results that can also be applied in other disciplines (especially in work by V. Kůrková). Approximation of functions by feedforward neural networks contributes to *mathematical theory of neurocomputing* and forms a new branch of *theory of nonlinear approximation*. Problems motivated by practical applications of feedforward neural networks in classification and pattern recognition tasks are formulated in a more general context of nonlinear approximation.

The results along these lines keep contributing to the development of a new branch of nonlinear approximation theory, to mathematical theory of neurocomputing and to design of learning algorithms.

Second, the problems related to efficiency of learning by neural nets have been tackled as well. For instance, the problem of NP-hardness of back propagation, which was conceived to be one of the main problems in the area of neural learning complexity, was solved positively (J. Šíma). Problems related to computational power and efficiency of neuroidal nets have also been considered by J. Wiedermann. R. Neruda has developed an original genetic algorithm that is suitable for learning of networks working with radial based functions. The respective algorithm performs faster than algorithms based on standard genetic learning. Other variants of evolutionary learning as well as hybrid algorithms are currently being investigated.

The monograph „Theoretical issues of neural networks“ (J. Šíma, R. Neruda, in Czech) summarizing the respective developments in the field and containing also original results by the authors was awarded Young Scientist Prize of the Academy of Sciences. Another monograph „Artificial Neural Networks – Theory and Applications“ (M. Novák et al., in Czech) has been used as university textbook.

The third line of research represents the research project on nuclear particle detection with the help of neural networks. It is based on data from the ATLAS detector on Large Hadron Collider (LHC) in CERN, Geneva. The cooperation with CERN is a long-term project. The neural network system for the detection of particles in events of B-physics was designed and was supported also by Barrande project (F. Hák, M. Jiřina).

Research in chaotic dynamics in neural networks is also worth mentioning.

Since its establishment in late eighties the group at hand has played a pioneering role in the respective domain in the Czech republic and there is a lot of evidence that is still keeps a leading position in this field.

Selected papers:

V. Kůrková, P. C. Kainen, V. Kreinovich: *Estimates of the number of hidden units and variation with respect to half-spaces.* Neural Networks 10, 1061-1068 pp., 1997

A major theoretical issue in neurocomputing is complexity, which must be considered with respect to a particular network implementation. In the case of currently widespread simulations on classical computers, feasibility of implementation is constrained by the number of computational units. Experience has shown that networks with a moderate number of hidden units can achieve quite good performance on many high dimensional tasks. Thus mathematical results showing that the number of hidden units does not necessarily need to increase with the dimensionality of the problem are of particular interest. The paper contributes to such results by characterizing sets of functions that can be approximated by neural networks with "dimension-independent" rates. Such sets are characterized in terms of an alternative notion of bounded variation for multivariable functions. This variation is estimated using "orthogonal flows through hyperplanes" that could be interpreted as dynamic versions of the Radon transform, on which tomography is based. Estimates are derived from an integral representation for smooth compactly supported functions proved using properties of Heaviside and delta distributions.

V. Kůrková, P. Savický, K. Hlaváčková: *Representations and rates of approximation of real-valued Boolean functions by neural networks.* Neural Networks 11, 651-659 pp., 1998

One of the main problems encountered for feedforward networks is so called "curse of dimensionality" of network architectures. As the size of the problem is scaled upward, complexity of such architectures may grow exponentially with the number of the network inputs. Some understanding of properties of high dimensional computational tasks that can be performed by networks of moderate complexity can be derived from certain results of nonlinear approximation theory that characterize dimension-independent rates of approximation in terms of certain norms. However, with increasing number of variables, sets of functions that can be approximated with such dimension-independent rates become more and more constraint. In the paper, tight estimates of such rates are derived and their strength and weakness is illustrated by constructing functions, for which the norms used in such estimates are growing either polynomially or exponentially with the number of variables.

J. Šíma: *Back-propagation is not efficient.* Neural Networks, Vol. 9, No. 6, 1996, pp. 1017-1023.

The most important feature of neural networks is learning and generalization capability whose complexity is studied within the framework of the PAC (Probably Approximately Correct) learning model which gave rise to a new informatics branch, the computational learning theory. Polynomial sample complexity, i.e. the number of training data was estimated for several neural network models by computing their VC-dimensions. However, there are mainly complexity-theoretic barriers to efficient learning in neural networks which has also been confirmed experimentally.

The most widely applied neural learning heuristics in practice is the back-propagation algorithm that appears to be very time consuming even for small network architectures or training tasks. The great effort had been invested to analyze the complexity of this algorithm but only partial results were achieved e.g. for binary states or irregular topologies. Several researchers announced this issue to be one of the most important open problems in neural learning complexity. This problem is solved in the present work where the respective learning problem is shown to be NP-hard for the differentiable standard sigmoid function which is employed in back-propagation learning. In general, this means that this heuristics is not efficient and no polynomial time algorithm exists for the underlying task, unless at least $P=NP$.

J. Šíma, R. Neruda: *Theoretical Issues of Neural Networks.* MATFYZPRESS, Prague, 1996, 390 p. (in Czech)

The interest in the so-called (artificial) neural networks which represent an alternative computational model to the von Neumann computer architecture has increased in the last decade. The introductory part of the book explains the neural network phenomenon in a popular way including historical and neurobiological motivations, conceptual comparisons to conventional computers, etc. This is followed by the rigorous technical description of several basic models such as perceptrons, back-propagation learning, Hopfield networks, Kohonen maps, RBF networks, etc. These models have successfully been employed to solve simple artificial intelligence tasks in which the standard algorithmic approach failed.

The core of the book consists in the theoretical analysis of neural networks from the complexity and approximation point of view. The efficiency of neural networks is studied along three lines: an efficient

creation of neural knowledge representation (learning and generalization complexity), its memory demands (descriptive complexity) and an efficient knowledge retrieval (computational power). In addition, neural networks are exploited to approximate functions and the results concerning universal approximation and functional equivalence are surveyed.

This book has successfully been used by researchers, engineers, lecturers and students of introductory and advanced courses on neurocomputing at most universities in the Czech and Slovak Republics.

A. Frolov, D. Húsek, I. Muravjev: *Informational Capacity and Recall Quality in Sparsely Encoded Hopfield-like Neural Networks: Analytical Approaches and Computer Simulation.* Neural Networks, Vol.10, 1997, No.5, pp. 845-855

A sparsely encoded Hopfield-like attractor neural network is investigated analytically and by computer simulation. Informational capacity and recall quality are evaluated. Three theoretical models are used: replica method (RM), method of statistical neurodynamics (SN) and single-step approximation (SS) for accuracy comparison and computer simulation results extension. Computer simulation confirmed a good accuracy of RM and SN for all levels of network activity. SS is accurate only for large sparseness. It is shown that informational capacity monotonically increases when sparseness increases, while recall quality changes nonmonotonically: initially it decreases and then increases. Computer simulation revealed the main features of network behavior near the saturation which are not predicted by the used theoretical models of network global behavior.

Medical Informatics

In the field of medical informatics the research focuses on problems of collecting and analyzing medical and health information in different forms. The research is concentrated in the following areas:

Electronic health record, medical databases and health information systems

We focus on special tasks connected with medical questionnaires, data registers, electronic health records and medical databases. The special research attention is devoted to the structured electronic health record and its multilinguality functions.

Medical guidelines, medical knowledge bases

Clinical practice guidelines are seen as a tool for improving the quality and cost-efficiency of care in an increasingly complex health care delivery environment. Computerization may increase the effectiveness of both the information retrieval of guidelines and the management of guideline-based care.

Decision support systems, expert systems

Here we concentrate on extracting relevant information using information theory tools. Further we are trying based on real medical data and medical knowledge to develop decision support and expert systems for applications in medicine and health care coping also with uncertainty.

The main results of the three above areas are in development of algorithms for extracting relevant information from medical databases using information theory tools, decision support and expert systems in cardiology and electronic health record in cardiology (J. Zvárová and co-authors).

Medical Statistics and Epidemiology

In the field of medical statistics and epidemiology the research focuses on the use of stochastic methods and new information and communication technologies in solving the problems of genetics, clinics and epidemiology. The research is focusing on extracting relevant information for decision support and decision support systems using statistical methodology and information theory tools. Further the research is focusing on genetic, epidemiological and clinical data analysis, on population and family studies, on association of risk factors and diseases, on diversity studies and on stochastic methods for individual identification. The main results are connected with analysis of genetic data and data from clinical and epidemiological studies and new approaches to education using new information technologies (J. Zvárová and co-authors).

There was also research in mathematical modelling of the medical data, especially laboratory data risk estimation with time dependent covariates and fuzzy probabilistic networks. The main result is a proposal of the original bivariate failure model for early detection of cancer disease recurrence and the proposal of the original fuzzy probabilistic network for the estimation of the localization of the primary tumor of unknown origin. The original models have been developed for the interpretation of laboratory data in gynecological endocrinology, thyroidal endocrinology, anaemias based on combination of fuzzy probabilistic networks and time series analyses (L. Pecen, K. Eben).

Mathematical modelling and numerical solution of problems in biomechanics

The main activity in this domain concerned the formulation of mathematical models for certain problems in biomechanics and the development of numerical methods for their solutions. A special attention was focused on contact problems arising in modelling of human hip joint and applications to Orthopaedic Practice (J. Nedoma and co-authors).

Suitable models for human hip joint were proposed. Furthermore, efficient numerical methods for biomechanical simulation were developed based on contact problem solution and application of the finite element approach. For this purpose, the special methods for constrained optimization were implemented. An application to loosened total hip replacement was described.

Medical informatics is a very important interdisciplinary field and the Institute plays a remarkable role in it on international level. The research carried in the Institute supports broadly the field of medicine and health care and brings tools for solving real medical and health care problems. There is great demand on expertise of researchers and educations in this field and the consequences of research results can accelerate the development of information society in health care.

Selected papers:

Zvárová J.: *On medical informatics structure.* Int. Journal of Medical Informatics Vol 44, 1, 1997, 75 - 81

The paper is the invited paper for the Int. J. of Medical informatics issue devoted to discussion of the paper of R. Haux: Aims and tasks of medical informatics. The paper of J. Zvárová is giving the overview of medical informatics definitions and introduces the new scheme of medical informatics structure. The structure is based on four information rings: Basic Information Ring, Methodology Information Ring, Interface Information Ring and Technology Information Ring. The medical informatics structure shows the key role of information in different forms in medicine and health care, new information methodologies and technologies important for the medical informatics field development. The medical informatics structure is in agreement with the scope of the Journal of American Medical Informatics Association and is in agreement with the views on medical informatics given by well known scientists in this field Gremy, Reichertz, van Bommel, Haux and Hasman.

The special issue of the International Journal of Medical Informatics edited by J. Zvárová, Vol, Nos. 1,2, published mainly Czech papers of the international Tempus conference "Information, Health and Education". As the important papers of the medical informatics field development we introduce:

Peleška J., Švejda D. and Zvárová J.: *Computer supported decision-making in therapy of arterial hypertension.* International Journal of Medical Informatics, Vol. 45, 1-2, 1997, 25-30

Therapy of hypertension is still more or less empirical. Several classes of antihypertensive medications are known, the effect of which is based on different mechanisms. The efficacy of treatment is not always a reliable indication of the appropriate selection of the treatment. A good therapeutical response can sometimes be achieved by the expense of humoral simulation. This can lead to harmful increased synthesis of tropic hormones. The decision support system is proposed and the costs of treatment considered. The beta version of the program HYPERTENSION was developed for practical applications. This type of research and close cooperation with physicians brought us to the ideas connected with medical guideline technologies for representing and sharing medical knowledge. Based on this research the project Medical Guidelines Technology was accepted by the EC to be solved in the 4th Framework Programme.

J. Zvárová: *Expert systems and relevant information,* Environmentrics 10, 1999, 493-504

To support medical decision making tasks successfully, we need to know whether the measured features on patients are relevant. In probabilistic expert system, optimal decision making is often based on the minimization of the average risk (Bayes risk). Therefore before we try to find the best probabilistic expert system, we should evaluate the medical data using data reduction and constitutions procedures. The information theoretic approach for data reduction and constitution also considers the criterion of the optimality as Bayes risk. The paper discusses the structure of probabilistic expert systems and gives examples of probabilistic expert systems running in clinical environment. Moreover, it considers more deeply the information- theoretical approaches to data reduction and constitution.

M. Nekulová, L. Pecen, J. Kraušitz, O. Topolčan, M. Šimíčková, V. Kolcová: *Primary Tumor of Unknown Origin: Computer-Assisted Ontological Diagnosis* (accepted to British Journal of Cancer)

About 3-5% cases in oncology are reported as "proved metastasis of unknown tumor". This rare but complicated situation occurs when one or more metastases were diagnosed but clinical examinations did not confirm any specific localization of their origin. The diagnostic program BIANTA (Bayesian Intelligent Associative Network for tumor analysis) for detection of the type and localization of the unknown primary tumor is based on patient results of some serum tumor markers measurements, patient sex, age and the epidemiologic knowledge of age and sex tumor incidence and large database tumor markers values in specific types of cancer. Results of tumor presence prediction obtained by this program are compared with consequently confirmed diagnoses. Totally in 93 patients the authors had success to verify the correct diagnoses. In 28 (30 %) patients the program predicted the correct diagnosis on the first place of all presumed diagnoses. In 61 (65.5%) patients the correct diagnoses were presumed on the second or the third places of program prediction. In 4 (4.5%) patients the system did not predict the correct diagnoses at all. Finally the formulation of interpreting algorithm offers useful answers in these difficult cases in oncology and therefore improves diagnostic process.

Study was supported by grant project of IGA MZCR No 3480-3

J. Nedoma, M. Bartoš, Z. Kestřánek, Z. Kestřánek, Jr., J. Stehlík: *Numerical Methods for Constrained Optimization in 2D and 3D Biomechanics*. Numerical Linear Algebra with Applications, Vol. 6, 1999, pp. 557-586

Artificial disabled human joint replacement, biomechanical function of both sound and disabled joints, bone fractures as well as surgical techniques in orthopaedic practice involve a great number of important biomechanical problems, their mathematical description and their numerical solution. These biomechanical problems can be modelled as 2D and/or 3D static and dynamic problems.

In the past 30 years, much experience has been gained and changes in the surgical techniques of the osteoarthritis of human joints have been made.

This paper formulates, analyses and discussed 2D and 3D static and dynamic model problems in the orthopaedic practice. Finite element approximations, algorithms and iterative methods for constrained optimization are discussed. Since the conjugate gradient method is one of the most effective methods for both unconstrained and constrained optimization, it can be applied without or with preconditioning for solving the basic step of the discretized problem. A comparison of several preconditioned conjugate methods is discussed. The problems discussed are applied to analyses of real patient. Finally, the numerical results are discussed.

Applications.

There are several application domains which the institute has been active. We mention the most important ones.

Mathematical modelling and numerical solution of problems in geosciences

The main activity in this domain concerned the formulation of mathematical models for certain problems in geosciences and the development of numerical methods for their solutions. A special attention was focused on contact problems with and without friction in thermoelasticity and termoplasticity, boundary value problems in 3D elasticity, nonlinear Stefan-like problems with coefficients dependent on pressure and temperature, problems in magnetodynamics and thermo-Bingham rheology problems. Besides mathematical analysis of these problems, the finite element approximation was applied requiring a special discretization methodology. The results culminated in the extensive monograph (998 pp) "Numerical modelling in applied geodynamics" by Nedoma, a deep synthesizing work with many very important new results.

GUHA and data mining

GUHA (General Unary Hypotheses Automaton) method originated in the middle sixties and was conceived as a procedure enabling to generate automatically, given a large collection of appropriately structured dichotomous data, all interesting statistical hypotheses supported by that data. Besides theoretical results, there are already numerous interesting applications of GUHA from various fields (medical and technical diagnostics, sociologic investigations, etc.). Note also a recent successful application of GUHA for neural network topology optimization. A new generation of the GUHA software has been developed, 1997/99, by a group of students of the Faculty of Mathematics and Physics, Charles University, Prague, under the supervision of A. Sochorová. At the same time, the theoretical development of the GUHA method continued, mainly in the area of vague hypotheses (M. Holeňa, P. Hájek).

Complex nonlinear time series in physics

Research was oriented to detection of phase synchronization, detection of a nontrivial dynamics embedded in colored noise and in detection of nonlinear oscillator underlying experimental time series. The developed original methods were tested using the famous sunspot data. A statistical evidence has been obtained that this data is underlayed by a driven nonlinear oscillator. This result is interesting from the viewpoint of nonlinear dynamics as well as from the viewpoint of solar physics (M. Paluš).

Application of numerical methods in environmental modelling

Based on a close and long-lasting collaboration with the state enterprise DIAMO, we consider a general nonlinear model of the underground water flow with transport of contaminants, also taking into account chemical reactions and free boundary conditions on the part of the boundary. The mixed and hybrid finite element discretization of the very flat three-dimensional domain (relatively large surface area with a thin layer in which the contamination takes place) results in very large, indefinite and ill-conditioned system matrices with a particular block form described. The results include not only original papers but also application of techniques to solving real-world problems.

CORBA technology with its Object Services and component-based systems.

The basic abstractions for modeling roles of parties involved in electronic market with software components have been identified: SOFA net, which can be viewed as a homogenous network of SOFA nodes. SOFA node abstraction models a party and the various roles the party takes in an electronic commerce with software components, e.g. producer, retailer, end-user, etc. Then a special component model that allows for dynamic component updating even in runtime of affected applications has been developed and prototyped (DCUP component model). Recently, to allow for describing component interface, internal architecture, and behavior, the SOFA Component Description Language with Behavior Protocols has been created. The described results are by far not mere applications of known results but present a creative and interdisciplinary activity yielding both practical results and new general methods (F. Plášil, D. Bálek and others).

Selected papers:

J. Nedoma: *Numerical Modelling in Applied Geodynamics*. John Wiley & Sons, Chichester, 1998.

The aim of this monograph is to provide mathematical bases and methods for analysing geophysical problems for global geodynamic models of the Earth and planets. It presents computational methods, based on variational formulations of model problems used in all areas of geosciences. Tectonic plates, seismic waves propagation, geothermal and electromagnetic fields, global geodynamics, geomagnetic and gravity models are all addressed. Emphasis is placed on the variational approach to the problems studied, which involves numerical analysis, whilst preserving the physical nature of the problems. The book details numerous applications of geodynamic and plate tectonic models which relate to constructions such as nuclear power plants, high level radioactive waste repositories, deep mines and water dams, under critical conditions.

M. Holeňa: *Fuzzy hypotheses for GUHA implications*. *Fuzzy sets and systems* 98 (1998) 101-125

Data mining has been one of the most rapidly developing information technologies of the last decade which aims at the extraction of useful knowledge from data. Data mining grew up from statistical and nonstatistical methods of exploratory data analysis, one of the oldest of which is the method called General Unary Hypotheses Automaton (GUHA). The GUHA paradigm, to automatically generate particular kind of logical formulae, which are supported by the available data, has been attracting attention since the seventies. Most of the procedures for generating such formulae, encountered in the existing implementations of the GUHA method, are based on statistical hypotheses testing. However, there is an inner contradiction inherent to using statistical tests to this end. Those tests always require a precise formulation of the tested conditions on the random variables characterizing the underlying real phenomena. On the other hand, exploratory data analysis is usually performed in situations when only a rather vague knowledge of those random variables is available, what casts doubt on any precise statement of the conditions to be tested. To solve that contradiction, a fuzzy generalization of the GUHA method is proposed in this paper. It is based on a method for fuzzy hypotheses testing, which was elaborated for the statistical tests used in GUHA and integrated into the context of logic. The paper concentrates on a particular kind of generated logical formulae, called GUHA implications. The fuzzy counterparts of the key concepts pertaining to GUHA implications are defined, and a number of their properties are established. The proposed approach is illustrated on two commonly used GUHA implications.

M. Paluš, D. Novotná: *Sunspot Cycle: A Driven Nonlinear Oscillator*. *Phys. Rev. Lett.* 83 (1999) 3406-3409

An energy output of the Sun as the main basis of life on the Earth is nearly constant. However, the Sun is far from being uniform. The best observed solar inhomogeneities are spots on the solar surface in which the luminosity is diminished but magnetic fields appear which are stronger than usual magnetic fields on the rest of the solar surface. Appearance of the spots on the Sun is quantified by so-called sunspot numbers, or index, which have been collected from the beginning of the 18th century. In 1852 Wolf reported the now well-know 11-year cycle. Of course, the sunspot cycle is not strictly periodic, but fluctuations in its amplitude as well as in its frequency occur. Therefore researchers have turned towards stochastic models in order to make predictions of the future behavior of the sunspot cycle. On the other hand, using methods developed in nonlinear dynamics and theory of deterministic chaos, several authors have claimed an evidence for the deterministic chaotic origin of the sunspot cycle. The used algorithms, however, have been found unreliable when applied to relatively short experimental data. A rigorous statistical evidence which would link the observed sunspot data and nonlinear physical model (such as those developed in the dynamo theory) has been lacking. In this work a property of nonlinear oscillators - mutual dependence between their instantaneous amplitude and frequency is tested in the yearly and monthly records of the sunspot numbers using the histogram-adjusted isospectral surrogate data and the Barnes model as the ARMA surrogates. The instantaneous amplitudes and frequencies are obtained by means of the analytic signal approach using the discrete Hilbert transform. In several tests the amplitude-frequency correlation has been found significant on levels ranging from $p < 0.03$ to $p < 0.07$, which supports the hypothesis of a driven nonlinear oscillator as a mechanism underlying the sunspot cycle. This result represents the first solid quantitative data-based evidence for a nonlinear dynamical origin of the solar cycle and should influence related fields in solar physics. On the other hand, the used method is an original one, and will find applications in analysis of complex and potentially nonlinear time series recorded in various fields of science and technology.

J. Maryška, M. Rozložník, M. Tůma: *The potential fluid flow problem and the convergence rate of the minimal residual method.* Numerical Linear Algebra with Applications 3 (1996) 525-542.

The paper represents a series of results on solving the potential fluid flow and transport in porous media which were obtained in our department. We concentrated mostly on analysis of a linear algebraic system which arises from mixed and hybrid finite element discretization of governing partial differential equations. Exactly this paper is devoted to the analysis of an iterative indefinite solver applied to the whole system. The other papers study properties of other approaches which established later a basis for new and very efficient codes for solving flow and transport in porous media. This work, which combines knowledge from various fields starting from numerical methods for partial differential equations, graph theory, methods of efficient algorithmic design, building software blocks up to solving real-world application still continues by finding new ways for solving nonlinear and time-dependent systems.

F. Plášil, M. Stahl: *An Architectural View of Distributed Objects and Components in Corba, Java RMI and COM/DCOM.* Software Concepts and Tools, Vol 19, No 1, 1998, pp. 14 - 28

With the wide spread utilization of object technology, it has become more and more important to employ the object oriented paradigm in distributed environments as well. This raises several inherent issues, such as references spanning address spaces, the need to bridge heterogeneous architectures, etc. It is the main goal of this paper to provide an architectural analysis of current software platforms in this area. One of the obstacles to overcome in order to achieve this aim is the fact that the available descriptions of these platforms speak different languages. Thus to target the issue, we have decided to employ design patterns as a common denominator which will help us provide an unified view on the platforms analyzed. We focus on the following key distributed object platforms: CORBA, Java RMI, and COM/DCOM

III Basic information on the Institute

1 Founding document of the Institute

ACADEMY OF SCIENCES OF THE CZECH REPUBLIC

Under the rule of the Act of the Czech National Council No. 283/1992 Coll. of the Academy of Sciences of the Czech Republic and further generally binding regulations the

FOUNDATION CHARTER
of the
Institute of Computer Science, AS CR

is modified as follows:

The Institute of Computer Science, AS CR, was established by the resolution of the 71st Session of the Presidium of the Czechoslovak Academy of Sciences held on November 26, 1974, with effect from July 1, 1975. By course of Sec. 18, para. 2, of Act No. 283/1992 Coll. the Institute has become an institute of the Academy of Sciences of the Czech Republic with the effect from December 31, 1992. (The initial name of the Institute, viz. the Institute of Computer Science and Computing Technology, AS CR, was changed on July 1, 1998).

The Institute of Computer Science, AS CR, (Ident. No. 6798 5807) is a legal entity — a partly budget-financed organization — established for an indefinite period with its seat in Prague 8, Pod Vodárenskou věží 2.

The director of the Institute is entitled to act on behalf of the Institute in all matters.

The purpose of the establishment of the Institute is to implement scientific research in the field of computer science, exploiting its workers' results and their applications.

The subject of activities of the Institute of Computer Science, AS CR, is scientific research in the field of computer science, particularly in computation methodologies, artificial intelligence, computer and information systems and the applications of computer science in related interdisciplinary areas.

The Institute contributes to increasing the standard of knowledge and education and applying the scientific research results in practice. It acquires, processes and extends and disseminates scientific information, publishes periodicals, papers, etc., organizes scientific meetings, provides scientific reviews, expert opinions and recommendations as well as consulting and advisory services. It offers post-graduate studies, doctorate study programs and educates prospective scientists. In the framework of its respective activities the Institute develops international co-operation and organizes conferences, seminars, etc. It performs its tasks both independently and in co-operation with Universities and other institutions.

The principal sources of the Institute's finances are contributions from the budget of the Academy of Sciences of the Czech Republic, funds obtained in accordance with the regulations concerning the state research support and development and funds acquired by its own activities.

The Institute is authorized to accept gifts and other resources from domestic and foreign physical and legal entities and to manage the property, which it has obtained the rights to.

A detailed specification of the property to which the Institute has the right of management is to be found in the enclosure forming part of this Foundation Charter.

Should the Institute be abolished all its property, after settling all its pledges and commitments, shall pass to the Academy of Sciences of the Czech Republic.

This modification of the Foundation Charter shall become effective on July 1, 1998. The same date the modification of September 1, 1993, shall be invalidated.

Prague, May 25, 1998

Professor Ing. Rudolf Zahradník, DrSc.
President

2 Organization of the Institute

2.a) Organizational chart of the Institute of Computer Science AS CR

2.aa) State as of 1995

Director

Vice-director for scientific research
 Vice-director for economical matters
 Scientific council
 Scientific secretary

Section 10 – directorate

dept. 11 – administrative
 dept. 12 – personal department

Section 20 – scientific research

dept. 21 – department of numerical methods
 dept. 22 – department of knowledge-based systems
 dept. 23 – department of neural networks
 dept. 24 – department of non-linear modeling
 dept. 27 – department of theoretical computer science

Section 40 – information services

dept. 41 – department of computer services
 dept. 42 – department of scientific information

Section 50 – administration

dept. 51 – department of technical maintenance
 dept. 52 – supply department
 dept. 53 – department internal administration
 dept. 54 – department of financial security

Section 60 – joint laboratories

dept. 61 – EuroMISE

Average number of employees converted to full-time contracts, as of 31. 12. 1995: 85,89

2.ab) State as of 1999

Director

Vice-director for scientific research
 Vice-director for economical matters

Convention of scientific workers

Scientific council
 Scientific secretary
 Director's Advisory officials

Section 10 – directorate

dept. 11 – administrative
 dept. 12 – personnel department
 dept. 13 – NNW Journal editorial office

Section 20 – scientific research

dept. 21 – department of numerical methods
 dept. 22 – department of knowledge-based
 dept. 23 – department of neural networks

dept. 24 – department of non-linear modeling
 dept. 25 – department of applied linear algebra
 dept. 27 – department of theoretical computer science

Section 40 – information services

dept. 41 – department of computer services
 dept. 42 – department of scientific information

Section 50 – technical and economic administration

dept. 51 – department of technical maintenance
 dept. 52 – supply department
 dept. 53 – department internal Administration
 dept. 54 – department of financial security

Section 60 – joint laboratories

dept. 61 – EuroMISE

Average number of employees converted to full-time contracts, as of 31. 12. 1999: 89,45

2.b) Structure of the staff

Category	up to 30	31 - 40	41 - 50	51 – 60	over 60	total:
RWA	7,18	12,12	12,79	14,88	5,54	52,51
RAS	2,34	0,50	3,00	1,57	1,33	8,74
CL			2,35	7,36	2,00	11,71
TECH	2,33	1,00	1,90	1,60	6,00	12,83
TECH			1,00	2,66		3,66
	11,85	13,62	21,04	28,07	14,87	89,45

Table 2: Structure of the staff by age as of Dec 31, 1999 (average no. of employees).

(RWA=research workers attested; RAS=research assistants; CL=clerks; TECH=technical staff.)

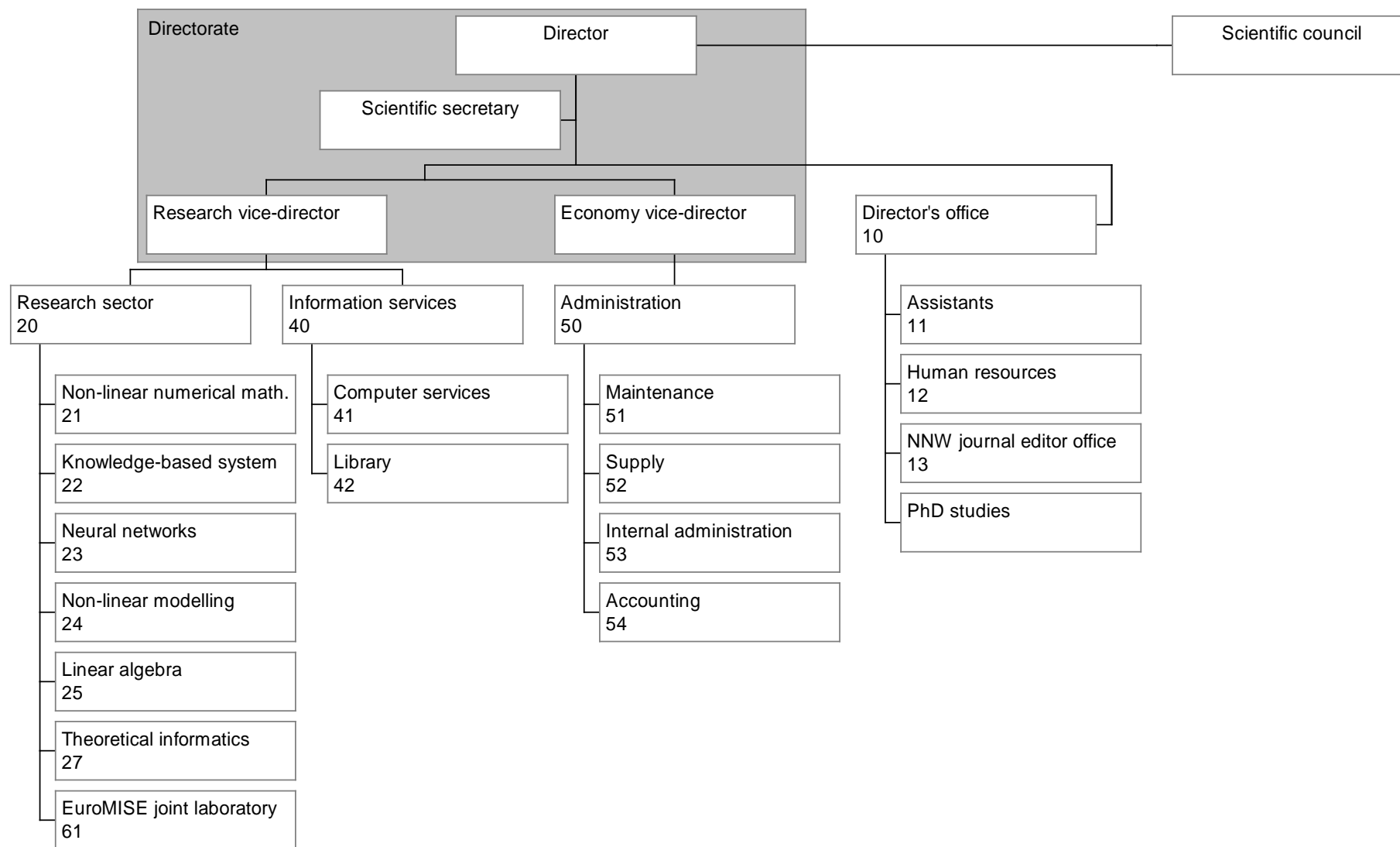


Table 3: Organizational chart of the ICS

2.c) List of names of all employees as of 31. 12. 1999

Adelsberger Petr, Ing.
 Andrej Ladislav, RNDr., CSc.
 Bálek Dušan, Mgr.
 Beneš Ladislav, Ing. CSc.
 Beneš Michal, Dr., Ing.
 Benešová Hana
 Benešovská Zdenka
 Bílková Hana
 Coufal David, Ing.
 Černá Hana
 Černý Silvan
 Daněk Josef, Ing.
 Daniel Milan, RNDr., CSc.
 Denksteinová Marie
 Drkošová Jitka, RNDr., CSc.
 Duffková Petra
 Eben Kryštof, RNDr., CSc.
 Erlebachová Věra
 Fabián Zdeněk, RNDr., CSc.
 Fajtová Anna
 Fantová Martina
 Fiedler Miroslav, Prof., RNDr., DrSc.
 Gaamanová Jana
 Golková Jaroslava
 Hájek Petr, Prof., RNDr., DrSc.
 Hakl František, Ing., CSc.
 Hanzlíček Petr, Ing.
 Harmancová Dagmar, prom. mat.
 Hejlová Anna, RNDr.
 Hlaváček Ivan, Ing., DrSc.
 Holeňa Martin, Ing., CSc.
 Honzíkova Zuzana, Mgr.
 Húsek Dušan, Ing., CSc.
 Chroustová Věra
 Jiřina Marcel, Ing., DrSc.
 Juruš Pavel, Mgr.
 Kačaba Jiří
 Kalda Miroslav, Ing.
 Kestránek Zdeněk, Mgr., PhD.
 Klán Petr, Doc., Ing., Mgr., CSc.
 Klaschka Jan, RNDr.
 Klímová Hana
 Kodym Ladislav, Mgr.
 Kostková Daniela, RNDr.
 Kramosil Ivan, RNDr., DrSc.
 Krumphanzl Oldřich, Ing.
 Krušina Pavel
 Křížek Josef, Ing.
 Křížková Zdeňka, Ing.
 Kulich Michal, Mgr., PhD.
 Kůrková Věra, RNDr., DrSc.
 Kurucová Jana
 Láska Vlastimil
 Ledecká Vlasta
 Lukšan Ladislav, Ing., DrSc.
 Maryška Jiří, Ing., CSc.
 Matonoha Ctirad, Mgr.
 Michalík Antonín
 Michalík František
 Michalíková Jaroslava
 Michálková Eva
 Morávková Marie
 Mužák Jiří, Ing.
 Nedoma Jiří, Doc., Ing., CSc.
 Neruda Roman, Mgr., CSc.
 Neužilová Ludmila
 Novák Mirko, Ing., DrSc.
 Nývltová Ludmila
 Paluš Milan, RNDr., CSc.
 Pecen Ladislav, RNDr., CSc.
 Pelikán Emil, Ing., CSc.
 Petrová Zuzana, Mgr.
 Plášil František, Doc., Ing., CSc.
 Podroužková Jiřina
 Polák Miloslav
 Pospíšilová Eva
 Pospíšil Radek, Mgr.
 Přebík Vladimír, Ing., CSc.
 Ramešová Nina, RNDr.
 Reissigová Jindra, RNDr.
 Rohn Jiří, Doc., RNDr., DrSc.
 Rozložník Miroslav, Ing., Dr.
 Říha Antonín, RNDr., CSc.
 Řízek Stanislav, Ing., CSc.
 Savický Petr, RNDr., CSc.
 Sochorová Ilona
 Starečková Vlasta
 Strakoš Zdeněk, Doc., Ing., CSc.
 Svatoš Jan, Mgr.
 Šafaříková Zdeňka
 Šebesta Václav, Ing., DrSc.
 Šíma Jiří, RNDr., CSc.
 Šimůnek Milan, Bc.
 Šiňorová Květoslava
 Štědrý Arnošt, Mgr.
 Štuller Julius, Ing., CSc.
 Štětková-Scherksová Nikol
 Tichý Petr, Mgr.
 Ťoupal Antonín
 Tůma Miroslav, Ing., CSc.
 Vančura Milan
 Vavříková Tereza
 Vlček Jan, prom. mat., CSc.
 Vojtáš Petr, Doc., RNDr., DrSc.
 Vondráček Jiří, prom. mat., CSc.
 Wiedermann Jiří, RNDr., DrSc.
 Zelenková Helena
 Zvárová Jana, Prof., RNDr., DrSc.
 Žák Přemysl, Mgr.
 Žák Stanislav, RNDr., CSc.

3 Names of the Institute's officials

	Head		Vice-head
Director	Hájek		Wiedermann Křížková
Scientific council	Štuller	ext.members:	Antoch Havlíček Mareš Segeth
		int.members:	Fiedler Lukšan Pelikán Šebesta Tůma
Scientific secretary	Neruda		--
Section 10	Hájek		Wiedermann
Dept. 11	Hájek		Wiedermann
Dept. 12	Černá		Křížková
Dept. 13	Novák		Harmancová
Section 20	Wiedermann		Šebesta
Dept. 21	Lukšan		Nedoma
Dept. 22	Kramosil		Harmancová
Dept. 23	Jiřina		Hakl
Dept. 24	Pelikán		Pecen
Dept. 25	Štrakoš		Tůma
Dept. 27	Šebesta		Šíma
Section 40	Štuller		Beneš
Dept. 41	Beneš		Adelsberger
Dept. 42	Štuller		Nývltová
Section 50	Křížková		Křížek
Dept. 51	Šafaříková		Křížek
Dept. 52	Chroustová		Krumphanzl
Dept. 53	Benešová		--
Dept. 54	Zelenková		Starečková
Section 60	Hájek		Zvárová
Dept. 61	Zvárová		Hanzlíček

Table 4: Names of the Institute officials as of December 31, 1999.

	Head		Vice-head
Director	Wiedermann		Štuller Křížková
Scientific council		ext. members:	Antoch Havlíček Mareš Segeth
		int. members:	Fiedler Lukšan Pelikán Šebesta Tůma
Scientific secretary	Neruda		--
Section 10	Wiedermann		Křížková
Dept. 11	Wiedermann		Křížková
Dept. 12	Černá		Křížková
Dept. 13	Novák		Harmancová
Section 20	Štuller		Šebesta
Dept. 21	Lukšan		Nedoma
Dept. 22	Kramosil		Harmancová
Dept. 23	Jiřina		Hakl
Dept. 24	Pelikán		Pecen
Dept. 25	Strakoš		Tůma
Dept. 27	Šebesta		Šíma
Section 40	Štuller		Beneš
Dept. 41	Beneš		Adelsberger
Dept. 42	Štuller		Nývtová
Section 50	Křížková		Křížek
Dept. 51	Šafaříková		Křížek
Dept. 52	Chroustová		Krumphanzl
Dept. 53	Benešová		--
Dept. 54	Zelenková		Starečková
Section 60	Wiedermann		Zvárová
Dept. 61	Zvárová		Hanzlíček

Table 5: : Names of the Institute officials as of March 15, 2000.

4 Budget of the Institute

	Institutional funding				Contracted funding				other sources			total	
Year	Personal	equipment	Total	perosnal	equipment	Total	personal	equipment	Total	personal	equipment	total	
1995	17 383	1 886	19 269	2 799	640	3 439	1 680	407	2 087	21 862	2 933	24 795	
1996	14 900	2 028	16 928	6 687	651	7 338	1 633	0	1 633	23 220	2 679	25 899	
1997	17 174	1 402	18 576	6 334	596	6 930	1 485	0	1 485	24 993	1 998	26 991	
1998	17 615	1 329	18 944	7 954	820	8 774	2 201	20	2 221	27 770	2 169	29 939	
1999	20 853	1 519	22 372	8 080	835	8 915	5 032	313	5 345	33 965	2 667	36 632	
S	87 925	8 164	96 089	31 854	3 542	35 396	12 031	740	12 771	131 810	12 446	144 256	

Table 6: Budget of the Institute during 1995–1999 (in thousands Kč)

5 Annual reports

– see Enclosures

6 A survey of all R & D activities during 1995 – 1999

6.a) A survey of scientific output

6.aa) List of scientific publications – see Appendix

		1995	1996	1997	1998	1999
1.	Books (or their parts)	9	4	3	13	6
2.	Textbooks		1	1	1	
3.	Dissertations		1	2	1	3
4.	Editorialships	3	1	1	2	2
5.	Papers in international journals	49	48	61	44	36
6.	Abstracts in international journals	6		16	4	16
7.	Papers in other journals	7	10	7	16	15
8.	Papers in proceedings of international conferences	56	49	47	47	42
9.	Abstracts in proceedings of international conferences	23	14	18	15	11
10.	Papers in proceedings of national conferences	4	8	3	15	17
11.	Reports	61	38	48	42	36
12.	Citations (citations in SCI)	188 (103)	206 (111)	257 (140)	318 (166)	207 (134)
13.	Invited papers	6	3	1	3	3

Table 7: Summary of publications in 1995–1999.

6.ab) Patents – no patents obtained

6.ac) Other special activities

Creation of databases:

A database SIS (based on the ISIS software) is maintained. Its main parts are: catalogue of the Institute's library, publications of the Institute's researchers, addresses of people and institutional, specialized databases on neural nets, expert systems, numerical and optimization methods, parallel computing and some others.

Note that the database of publication of the Institute's researchers includes citations of works included; the quality of this database is documented by the list of scientific publications (point aa above) prepared directly from it.

Besides, a searchable database Czech Chemistry was prepared and displayed on the Internet (chemie.upce.cz). Last but not least, a database of patients of a 20 year lasting longitudinal study of atherosclerosis (more than 1000 patients) has been realized.

Joint laboratories

The European Center for Medical Informatics, Statistics and Epidemiology of Charles University and Academy of Sciences (EuroMISE) was set up in 1994 as one of the objectives of the TEMPUS PHARE JEP 4358 EuroMISE project (education) and COPERNICUS JRP 10053 MUM project (research). Based on the decisions of Charles University and Academy of Sciences the joint workplace EuroMISE Center is legally represented in frame of Charles University by the Faculty of Mathematics and Physics and in frame of Academy of Sciences by the Institute of Computer Science. The main targets of the EuroMISE Center of Charles University and Academy of Sciences are the following:

- To create an European teaching network for higher education in medical informatics, statistics and epidemiology, to organize and launch graduate and postgraduate education on international level
- To initiate international joint research and development programs in the interdisciplinary field of medical informatics, statistics and epidemiology, to cooperate closely with health care sector.

Joint Laboratory of System Reliability (LSR) was founded in summer 1996 in the range of the program of university research enhancement of the Ministry of Education of the Czech Republic. The main research activity of this Laboratory is concerned with the research program „Signals, Processes and Factors of Reliability in Complicated Systems, especially in Transportation“. The dominant goals of this project are:

- To create a new laboratory (LSR) as a specialized research department of the Faculty of Transportation, which will be oriented to problems of control, monitoring and operation automation of transportation systems, with special regard to their reliability and life-time.
- To develop the suitable theoretical, methodical and program basis of predictive diagnostics.
- To create a research team with necessary interdisciplinary character.
- To prepare projects in which the obtained theoretical and methodical results can be projected in real practical problems.
- To present both theoretical and practical results on relevant scientific conferences, symposiums and seminars and their publications in scientific journals and books.

Presently, about 25 people work on the research of predictive diagnostics and its applications. The LSR also cooperates in this area with other universities and research institutes, e.g. with Military Academy Brno, the Czech Air Force Technical research Institute, Prague, Delft University of Technology, the Netherlands, and King's College, London are to be mentioned. Formally the Laboratory is a part of the Department of nonlinear modeling.

Publishing and editorial activities

First, the Institute has published the international journal *Neural Networks World* since 1990; the journal is now in its tenth volume. The journal has good scientific quality and has contributors from many countries all over the world. Some issues are specialized and they often serve as proceedings of relevant conferences.

Occasionally the institute becomes the publisher or co-publisher of a book. The following are two examples:

- Klán P., Mindl J., Štědrý A., Rubešová E.: *Chemical informatics – an introduction to the use of Internet*. Published by ICS AS CR, CHEMagazin, ČSCH, University Pardubice.
- *Colloquium Logicum – 1999 Yearbook of the Kurt Gödel Society*. Published by ICS AS CR.

Second, several researchers have been members of Editorial Boards of scientific journals. The list of these journals follows.

- *Applications of Mathematics* (L. Lukšan)
- *Archive for Mathematical Logic* (P. P. Hájek)
- *Computers and Artificial Intelligence* (P. Hájek)
- *Czechoslovak Mathematical Journal* (M. Fiedler, P. Hájek)
- *Electronic Journal of Linear Algebra* (M. Fiedler)
- *Fundamenta Informaticae* (P. Hájek)
- *International Journal of Computational Intelligence and Organization* (E. Pelikán)
- *International Journal of Forecasting* (E. Pelikán)
- *Journal of Network and Computer Applications* (F. Plášil)
- *Kybernetika* (P. Hájek, I. Kramosil)
- *Linear Algebra and its Applications* (M. Fiedler)
- *Mathematica Slovaca* (M. Fiedler)
- *Methods of Information in Medicine* (J. Zvárová)
- *Neural Networks World* (J. Wiedermann, M. Novák, D. Harmancová, M. Jiřina, R. Neruda, S. Řízek)
- *Neural Processing Letters* (V. Kůrková)
- *Numerische Mathematik* (M. Fiedler)
- *Physician and Technology* (J. Zvárová)
- *SIMAX* (Z. Strakoš)
- *Soft Computing* (P. Hájek)

Finally, the Institute's researchers are often editors of Proceedings of international and domestic conferences (see Section 8.e)).

Expert activities, consulting,

Expertise and research studies in analysis of time series were done for

- Czech Hydrometeorological Institute, Prague
- Gas Distribution Company, Prague
- West Bohemian Gas Distribution company, Pilsen
- Middle Bohemian Gas Distribution company, Prague
- West Bohemian Power distribution company, Pilsen

Expertise in fluid flow and transport of contaminants was done for DIAMO, s.p., Stráž pod Ralskem

One researcher (V. Šebesta) is a member of the Board for Research and Development TECHNOS at the ministry of Industry and Trade, auditor for the certification of quality systems in the field of information technologies, SW and HW according the standard ISO 9000 and assessor of EFQM (European Foundation on Quality Management) for the European Quality Award

Several researchers have served in commission of various Czech grant agencies. J. Zvárová was twice asked by the European Commission to participate in the evaluation of European projects.

Activities for general public, participation in education of high school students.

Popularizing articles were published in the following newspaper and journals: Hospodářské noviny, Computer world, PC World Chip, Computer Echo, Forum, Lékař a technika, Zdravotnické noviny, Sborník lékařský, Medical Marketing (see Appendix).

Cooperation with secondary schools:

R. Neruda was teaching programming at "První obnovené reálné gymnázium", Prague in 1995-1998.

P. Klán is a member of National Committee for Scientific High School Activities; M. Fiedler is a vice-head/member (since 1998) of the Central Committee for the Czech Mathematical Olympic Competition; J. Šíma had popularization lectures for students from secondary school (Vimperk, 1999); EuroMISE prepared two courses and consultations for the Higher Nursing School of Prague in the years 1998 and 1999.

Last, but not least, the Institute organized in 1998 and 1999 the *Days of open doors* for students of secondary schools and universities as part of the Days of Science organized by the Academy. Although the number of visitors was not too big, there were very vivid discussions and the students showed serious interest in computer demonstrations.

6.b) and c) List of grants and research projects with contracted funding from the national budget or international sources in 1995-1999.

Most projects are funded from the national budget. Project denoted by (E+Cz) were financed both by foreign sources (EU projects or similar) and from the national budget. Project not supported from national budget are denoted by (E) (external).

	1995	1996	1997	1998	1999
Grant agency of Academy of Sciences of CR	6	6	6	7	6
Grant Agency of CR	18	14	12	11	10
International	4	3	3	2	3
Ministry of Education	1	4	3	4	4
Ministry of Foreign Affairs		2	2	2	1
Ministry of Industry and Trade		1	1	1	1
Badatelský		1	1	1	1
Ministry of Environmental Control			1	1	
Ministry of the Interior				1	1

Table 8: Overview of number of grants awarded in 1995–1999.

List of projects supported by state budget**1. GA201/95/0992*****Extensions of Modular Neural Network Paradigms and their Applications in Medicine, 1995-1997, Ladislav Andrej***

Study of paradigms and techniques generalising principles of neural network theory especially in direction which need deeper utilisation of biological motivations and will allow next development of theory as well as modelling of more complex biological systems and widening of field of applications.

2. RN19982003011***Application of Quantum Information in Cryptology – Quantum Theory of Information, 1998-2003, Ladislav Andrej***

Quantum computation is based in physical-mechanics principle of superposition and coherence, which allows to form a large number of parallel computations at the same time. Quantum physics allows creating absolutely safe crypto systems. Authors will use broad knowledge from classical information theory, quantum physics and complexity theory for building this new discipline.

3. GA305/99/0049***Study of Behaviour of Neurons in Normal States and Pain by Methods of Chaodynamics-experimental and Theoretical Approach, 1999-2001, Ladislav Andrej***

For three basic models of pain, especially of model of neurotic pain, deafferative pain and arthritic pain will be sampled activities of firing neurons in two parts of thalamus. These records will be analysed using methods of chaodynamics. Finally influence of analgesia different types will be modelled.

4. A 230106 1993-95***Mathematical modelling of metastatic activity of cancer cells, 1993-1995, Kryštof Eben*** (investigator)

The risk factors of metastases in cancer patients were studied and methods for early detection of metastases have been developed, based mainly on statistical analysis of tumor markers measurement.

5. IAA 1075709***Information-theoretic criteria of goodness-of-fit between data and probabilistic models, 1997-1999, Zdeněk Fabián*** (co-investigator).

Development of statistical methods for evaluation of the degree of correspondence between data and their probabilistic models, based on information-theoretic divergences between data distribution and a parametrized model distribution.

6. IAA130407***Structured matrices, 1994-1996, Miroslav Fiedler*** (investigator)

The project is devoted to research of special matrices. The classes of Hankel, Toeplitz, Vandermonde, Cauchy, Loewner and Bezout matrices and their generalizations are studied.

7. GA201/95/1484***Linear problems with inexact data, 1995-1997, Miroslav Fiedler*** (investigator)

The project is devoted to computations with inexact data. The subject is rather actual because of wide use of electronic computational facilities. The techniques of convex analysis, interval arithmetic, fuzzy sets and perturbation theory are used in this project.

8. IAA1030701***Extensions of linear-algebraic problems, 1997-1999, Miroslav Fiedler*** (investigator)

Linear-algebraic problems are extended in three directions. The coefficients can be either matrix blocks or members of noncommutative sets. The project concentrates also on problems with positive-definite quadratic forms or positive quartic forms. All the directions are strongly motivated by solving technical applications and problems of theoretical physics.

9. GA201/98/0222***Linear algebra and its applications to optimization problems with inexact data, 1998-2000, Miroslav Fiedler*** (co-investigator)

The project deals with the research of influence of inexact input data on quality of the results. The basic three approaches to the problem are considered. The first one is based on interval arithmetic, the second is based on data from fixed sets and the third uses data defined via special pseudoconcave functions.

10. IAA 130108

Mathematical foundations of approximate inference, 1993-1995, Petr Hájek (investigator)

The aim of the project is to attribute towards a deeper mathematical understanding of various approaches to inference under uncertainty in their mutual relations.

11. OK 255 (E+CZ)

MUM (Managing Uncertainty in Medicine) COPERNICUS, 1994-1996, Petr Hájek (investigator)

The goal of the project is to take part in the theory of managing of uncertainty. Theoretical research in fuzzy logic and in the theory of belief functions, inovations of the existing software. Practical applications to medical empirical data.

12. A 1030601

Mathematical foundations of inference under vagueness and uncertainty, 1996-1998, Petr Hájek (investigator)

The aim was to contribute to an unified mathematical theory for fuzzy logic and logics of uncertainty. For this purpose a well elaborated mathematical propositional and predicate fuzzy logic has been crated and its relation to logics of uncertainty was analyzed.

13. OC 15.10

Mathematical foundations of fuzzy logics and its applications, 1996-1999, Petr Hájek (investigator). Part of COST action 15 – Many valued logics for computer science applications.

Mathematical foundations of many-valued logics taken as a basis for fuzzy logic: problems of axiomatizability and completeness. Logical foundations and criticism of the use of fuzzy logics in applications (fuzzy control systems, fuzzy expert systems). Logic of vagueness and uncertainty. Mathematical exactness as the absolute priority.

14. KSK 1075601

Tools and methods of mathematical computer science, cybernetics and information transmission, 1996-2000, Petr Hájek (co-investigator)

Creation of sophisticated models for information and control systems, including the deduction of theoretical and mathematical tools how to handle these systems and how to develop them till the level of applicable methods and technical principles.

15. IPP 2012801

Transmission, processing and protection of large data sets, 1998-2000, Petr Hájek (co-investigator).

The goal of the project is to complete the information – technical structure of working places in question by tools necessary for transmission of large data servers; this research will enable to incorporate the working places of the Acad. of Sci. of the Czech Rep. into the international cooperation at the adequate level.

16. GA201/95/0979

Pattern Recognition Method Based on Univalent of Neural Net Mapping, 1995-1996, František Hák

The main subject of the grant proposal is acceleration of the learning procedure for neural network. Special attention is addressed to the problem of pattern recognition. Neural nets mapping input space to out put space in a one-to-one manner is able to reflect the geometrical shape of separated classes. In such a case it is possible to introduce a penalization of patterns lying in the interiors of the separated sets. I is useful eliminate these penalized patterns. Univalence of the mapping realized by neural net guaranties the performability of this approach. Reduction of learning pattern follows acceleration of learning process.

17. ESPRIT Project 7364 (E)

Jessi Common Framework, July 1993-June 1995 (collaborating researcher: **Martin Holeňa**)

18. HC Project 1019(E)

Healthcare Advanced Network System Architecture, July 1996-June 1998 (collaborating researcher: **Martin Holeňa**)

19. Project No. 0339590 of the German Federal Ministry for Education and Research (E)

Auswirkungen von Bühnen auf semiterrestrische Flächen, January 1999-September 2000 (collaborating researcher: **Martin Holeňa**)

20. GA102/94/0728***Information Retrieval from Textual Databases Based on AI and NN Methodology, 1994-1996, Dušan Húsek***

Elaboration of methods and algorithms for searching in text databases with respect to obtaining maximal number of relevant texts as response to user's question. For solving will be used non-boolean models of text (vector models, special logic, feedback, signatures) and neural networks. The problem will be solved not only on scientific level, but a part of solution will be implementation of designed algorithms. The results of the project can serve as a basis for non-traditional text systems, e.g. of juridical information systems, documentation systems, systems of scientific information etc.

21. GA201/94/0729***Analysis of Informational Capabilities of a Class of Artificial, 1994-1996, Dušan Húsek***

Building a theory and elaboration of methods and experimental software for stating information capacity of selected artificial neural networks. Analysis of behaviour of individual types of networks from the point of view of information capacity. Optimisation of structure of artificial neural networks with respect to information capacity and application of new knowledge from neurophysiology.

22. GA201/97/0885***Analysis of Informational and Dynamical Capabilities of Recurrent Neural Networks, 1997-1999, Dušan Húsek***

The target of the project is research of informational and dynamic properties of associative memory based of sparsely coded Hopfield network in asynchronous regime. Mathematical methods as well as computer simulations will be used and effectiveness of this kind of neural network will be compared with traditional methods of pattern recognition.

23. Barrande 99010-1***Analysis of Informational and Dynamical Properties of Neural Networks, Dušan Húsek***

The goal of the project is investigation of informational and dynamic properties of recurrent class of neural networks (ANN) both by analytical approaches and by computer simulation. It implies development of analytical approach to the investigation of non-equilibrium behavior of sparsely encoded neural networks stochastic in learning and/or activation dynamics, and computer simulation of these networks and comparison of the results with those obtained analytically.

24. GA102/93/0912***Automatic Identification of Plants Growing in Rows by Means of Neural Nets, 1993-1995, Marcel Jiřina***

The task of identification and localisation of position of cultural plant will be solved using neural networks for evaluation of data from sensor. The reason for usage of neural networks is large variability and a bad quality of primary data. We will search for static neural systems as well as neural systems with continuous learning. The identification will be used for control of machines for weed liquidation that is solved in another application oriented project.

25. GA202/93/0178***Hadron Interactions in TeV Region and Their Fast Triggering for the Quark-Physics, 1993-1995, Marcel Jiřina***

Interaction of proton-proton at 16TeV energy under cooperation on the experiment ATLAS in CERN where it is a part of project LHC-CERN. Our contribution: 1. Computer simulation of interactions from the point of view CP invariance and investigation of b-quark and t-quark. 2. Tracking system and identification of charged particles in inner detector of ATLAS, 3. Design of architecture for quick selection of interaction with given topology using Neural networks, 4. Development of high-speed optoelectric neural network for second level triggering.

26. Barrande No. 97052***Application of neural nets for triggering of events in particle physics, 1997-1998, Marcel Jiřina***

Study of CP symmetry violation in decay of B-particles in high energies. The target is research and elaboration of methods based on neural networks for application in so called demonstrator of detector system.

27. Project No. RP-4210/69/97

Cooperation of the Czech Republic with CERN. Czech Ministry of Industry and Business, 1997-2003, Marcel Jiřina

Cooperation with Institute of Physics, CAS (Prof. Niederle).

Project of scientific and technological participation of Czech scientific institutions in study of particle physics and development new particle detectors in CERN. The project consists of particle physics

theory part, participation in particle physics experiments, and participation in development of new detectors.

28. COPERNICUS CP93-9630 (E+CZ)

Microcontroller-Framed Innovative Technology: Instruments for Adaptive Control, 1994-1996, Petr Klán

The project was concerned with the development and production of innovative digital instruments (controllers and probes) for the control of industrial processes. These instruments have combined a control hardware environment based on Philips advanced microcontrollers with innovative algorithmic control techniques based on the knowledge and experience of control specialists; the probes have helped to obtain data information with which the controller process may be analyzed.

29. IZ 1407

The structure and dynamics of relationship between the psychological profile and embodiment of students of medicine, 1993-2000, Jan Klaschka (co-investigator, principal investigator: Dr. Jiří Kožený, Prague Psychiatric Centre)

The project was aimed at (i) the development of the theoretical and empirical bases for a psychological description of applicants for admission to the Medical Faculty, (ii) prediction of success of the professional embodiment of medical students, (iii) development of a methodology of individualized entrance examination.

30. IZ 1808

The determinants of the differential treatment response in patients with Alzheimer disease, 1994-1995, Jan Klaschka (principal investigator)

The aim of the project was to find a typology of change profiles in patients with Alzheimer disease, as well as biological and psychometric correlates of the typology. The search for the typology was based on analyses of the data from a multicentre Selegiline trial.

31. IZ 1811

Perinatal diazepam treatment and the risk of delayed behavioural and neuro-immunobiological deviations, 1994-1996, Jan Klaschka (co-investigator, principal investigator: Dr. Olga Benešová, Prague Psychiatric Centre)

The aim of the study is to argue against the traditional prejudice that the risk of teratogenicity of medicaments is confined to the first gravidity trimester. Using an animal model, an increased risk of the functional teratogenicity of the perinatal diazepam treatment (a routine treatment in obstetrics and neonatology) was proved.

32. IZ 1807

Development of the psychological method of the newborn behavior assessment, 1994-1998, Jan Klaschka (co-investigator, principal investigator: Dr. Eva Šulcová, Prague Psychiatric Centre)

A clinical method was developed. Its first part is designed to the assessment of behaviour of the mother and newborn during the breastfeeding. The second part is focused at spontaneous and reactive behaviour of the newborn after the breastfeeding.

33. IZ 3706

Psychometric study of the positive and negative symptoms of schizophrenia, 1996, Jan Klaschka (principal investigator)

The aim of the project was an assessment of psychometric properties of the Czech version of the Positive and Negative Symptoms Scale (PANSS) for schizophrenia, inter-rater reliability being the parameter of primary interest.

34. IZ 3704

The dermatoglyphic norm of Czech population and its application for screening of early prenatal disturbances, 1996-1998, Jan Klaschka (co-investigator, principal investigator: Dr. Zdeněk Klein, Prague Psychiatric Centre)

Using dermatoglyphic data (30 elements) of 400 healthy men and women, a norm for the Czech population was established. The norm should be used for the screening of those diseases where the action of a pathogenous noxa is assumed to take place within the first trimester of the prenatal life.

35. IZ 3703

Effect of glutamate in vitro on the high-affinity choline uptake and lipid peroxidation in brain tissue, 1996-1999, Jan Klaschka (co-investigator, principal investigator: Ing. Zdena Křištofiková., Prague Psychiatric Centre)

The aim of the study was testing of the "in vitro" effect of L-glutamic acid to the presynaptic activity of the cholinergic synapses, and to the lipid peroxide levels in the brain tissue damaged by normal and pathological aging.

36. IZ 3703

Pharmacotherapy and psychotherapy in the treatment of social phobia - two years follow up study, 1996-1999, Jan Klaschka (co-investigator, principal investigator: Dr. Ján Praško-Pavlov, Prague Psychiatric Centre)

In a double-blind study, 3 treatment methods (pharmacotherapy, cognitive therapy, pharmacobehavioural therapy) in patients with the social phobia were compared. The 6 month effects, as well as the 2 years catamnestic results were evaluated.

37. IZ 4014

Risk of persistent neuro-immuno-behavioural deviations induced by perinatal administration of indomethacine, 1997-1999, Jan Klaschka (co-investigator, principal investigator: Dr. Olga Benešová, Prague Psychiatric Centre)

In an experiment with rat models, the risk of perinatal administration of indomethacine (a medicament routinely administered to the premature newborns) was studied by the lifelong observation of behaviour, measurement of immunoreactivity, and biochemical analysis of the brain.

38. GA309/95/1083

Study of neuroimmunobiological effects of nootropics, Jan Klaschka (co-worker, principal investigator: Dr. Olga Benešová, Prague Psychiatric Centre)

In an animal experiment (long-term peroral administration of nootropic drugs to aging rats), the mechanism of nootropic action was studied. At the same time, an improved methodology of preclinical assessment of newly designed nootropic drugs was developed.

39. GA 201/93/0781

Building intelligent systems, 1993-1995 Ivan Kramosil (co-investigator)

Creation of software tools enabling to test various theoretical approaches towards the building of intelligent systems, teaching these techniques at high schools and making easier to implement intelligent systems into practical use.

40. IAA 1030504

Alternative mathematical models for uncertainty quantification and processing, 1995-1997, Ivan Kramosil (investigator)

Investigation of non-probabilistic and non-statistical models for uncertainty quantification and processing, their mutual relations and relations to probability theory, Dempster-Shafer theory (belief functions), possibilistic measures.

41. IAA 1030803

Alternative mathematical models for uncertainty quantification and processing, 1998-2002, Ivan Kramosil (investigator)

Mathematical models for managing with uncertainty and based on theoretical foundations alternative to the classical probabilistic and statistical models. Includes Dempster-Shafer theory, possibilistic measures and measures with non-numerical or nonstandard (Boolean) values.

42. GA201/93/0427

Approximation of Functions and Architectures of Neural Networks, 1993-1995, Věra Kůrková

The goal of the project is to develop a mathematical background for choice of neural networks architecture (typ of units and their activation functions, their number and interconnection) from the standpoint of the theory of approximations of functions. There will be used methods from functional analysis for investigating approximation capabilities of various types of architectures popular in applications and coding theory for optimal representation of output signals.

43. A 2030602

Complexity of Continuous Models of Neurocomputing, 1996-1998, Věra Kůrková

Characterization of mathematical properties of functions that can be approximated by neural networks from the stand point of complexity of both the network architecture and parameterization

44. GA201/96/0917

Approximation of Functions and Neural Networks Learning Algorithms, 1996-1998, Věra Kůrková

The goal of the project is to investigate properties of sets of functions computable by multilayer feedforward neural networks using techniques of the theory of approximation of functions and

functional analysis. Constructive results achieved will be applied to design of neural networks learning algorithms.

45. GA201/99/0092

Nonlinear Approximation by Neural Networks, 1999-2001, Věra Kůrková

The goal of the project is to contribute to the development of a new branch of nonlinear approximation theory devoted to the approximation from sets of functions computable by neural networks. Using methods of real, complex and functional analysis we will investigate properties of approximation operators and derive estimates of rates of approximation. Constructive results will be applied to concrete design of new techniques for function approximation.

46. GA201/93/0429

Research of optimization methods and development of an interactive system for universal functional optimization, 1993-1995, Ladislav Lukšan (investigator).

The main purpose of the research is a theoretical and practical investigation of optimization methods and a development of optimization algorithms based on modern approaches such as sparse matrix technology, parallel processing, automatic differentiation and knowledge bases. Attention is mostly focused on structured nonlinear programming, nonsmooth optimization and parameter estimation of dynamical systems.

47. GA201/96/0918

Development of methods for solving large-scale problems of nonlinear analysis, 1996-1998, Ladislav Lukšan (investigator).

The project deals with the development of methods for large-scale nonlinear analysis and optimization, and their incorporation into the universal software system UFO. This project concerns methods for sparse and partially separable unconstrained optimization, fully iterative methods for large-scale systems of nonlinear equations, interior point methods for linear and quadratic programming and SQP methods for equality constrained nonlinear programming and optimal control problems.

48. GA308/95/0304

Mathematical models of hip joint, surgical reconstruction of hip joint based on its stress analysis, 1995-1997, Jiří Nedoma (co-investigator)

The project concerns the formulation of mathematical models for certain problems in biomechanics and the development of numerical methods for their solutions. A special attention is focused on contact problems arising in modelling of human hip joint and applications to Orthopaedic Practice.

49. OK158+COPERNICUS CP94-0820 (E+CZ)

High performance computing in geosciences 1: Safety of constructions with respect to rock deformations and movements, 1996-1998, Jiří Nedoma (investigator).

The project is focused on the research of mathematical methods (based on a finite element method) for modelling processes in lithosphere. The main attention is devoted to 2D and 3D contact problems, especially to a quasi-dynamic Signorini-type contact problem with friction and coupled Stefan problems of thermo-visco-plastic Bingham reology.

50. OK407+COPERNICUS CP97-7006 (E+CZ)

High performance computing in geosciences 2: Safety of constructions with respect to rock deformations and movements, 1999-2001, Jiří Nedoma (investigator).

The project is focused on the research of mathematical methods (based on a finite element method) for modelling processes in lithosphere. The main attention is devoted to 2D and 3D contact problems, especially a to quasi-dynamic Signorini-type contact problem with friction and coupled Stefan problems of thermo-visco-plastic Bingham reology.

51. GA404/98/1565

The Lovosice Region in the La Tène and Roman Periods of Central Europe, 1998-2000, Roman Neruda

The targets of the project are 1. To reconstruct landscape in time of breaking era and in this landscape to localise individual newly found deposits 2. To reconstruct and compare economic systems of La Tène and Roman periods, 3. To solve problems of origin of cultural periods.

52. GA201/99/P057

Parameter Spaces and Learning Complexity of Neural Networks, 1999-2002, Roman Neruda

Functional description of equivalent neural networks of different type (RBF, multilayer perceptrons) will be used for finding new learning algorithms which are able to search reduced parameter spaces. It will be used e.g. modified genetic algorithm. The influence of reduced parameter space and time

complexity of learning will be studied and the algorithms will be realised if possible also in parallel environment.

53. GA 101/93/0430

Theory and Methods for designing Systems with Higher Reliability, 1993-1995, Mirko Novák

The goal of the project was the development of the theory of high reliability systems and a proposal of methods to increase their reliability in non-technological ways. An approach based on time series prediction (namely artificial neural networks) and an analysis of reliability intervals has been used for life span estimates of technological systems. Practical usability has been tested on concrete examples, especially from energetics and airspace engineering.

54. GA102/95/1311

New Predictive optimization methods for application in energetics network for the Czech Republic, 1995-1997, Mirko Novák (main investigator)

The aim of the project was to develop to methods for optimization and prediction of the main significant operation parameters in production and distribution in electric power network of the Czech Republic.

55. GA102/96/0183

Procedures for improvement of reliability and life-time technical systems by use predictive diagnostics, 1996-1998, Mirko Novák (main investigator)

The aim of the project was to develop to methods, algorithms and program tools for non-technological approaches for reliability improvement. The investigators used modern information technologies, especially artificial neural networks for this purpose.

56. GA CR 205/97/0921

Prediction of Central European climate evolution based on the solar inertial motion and non-linear analysis of solar-terrestrial and climatic time series, 1997-1999, Milan Paluš (co-investigator, the main investigator Dr. I. Charvatova, Institute of Geophysics AS CR)

Solar-terrestrial and climatic time series have been processed by modern and standard methods. Long-term trends and irregular oscillations have been detected which could occur due to the solar inertial motion (agreement in significant frequencies and agreement of temperature maxima with recurring formations in the solar movement). The latter implies that the climate in Central Europe would possess a slightly decreasing temperature trend and low-amplitude irregular oscillations with periods in the range 8-16 years.

57. IGA - Grant No. 3767-3:

The evaluation of tumor markers follow up and cellular markers for breast carcinoma patient diagnose and prognose estimation, 1996-1998, Ladislav Pecen

The goal of the project is to propose optimal prediction models for early detection of breast carcinoma recurrence, patient's prognose estimation and therapy evaluation.

58. IGA - Grant No.4870-3 :

The new methods for the prognose estimation of tyroidal cancer patients, 1999-2001, Ladislav Pecen

The problems of thyroid gland carcinoma diagnose, patient's prognose estimation is solved, models are based on optimally selected histological findings and serum laboratory parameters.

59. IAA230404

Design of modular artificial neural networks, 1994-1996, Emil Pelikán (main investigator)

The main goal of the project was to study the principles leading to design of neural network architectures with a high degree of modularity. The interest was focused o application areas, where complex data collected from various information sources were available. Using special strategies and optimizing techniques the modular neural networks were applied in medicine, energetics and economy.

60. GA201/94/0130

New Approaches to Neural Networks in Digital Signal Processing for Applications to System Identification and Modelling, 1994-1996, Emil Pelikán (co-investigator, main investigator: Dr. Aleš Procházka, Czech Technical University)

The project goal was in the interdisciplinary research of general digital signal processing methods and new architectures of neural networks, adaptive methods and discrete transforms. Basic interest was in analysis and identification of nonlinear systems and nonstationary discrete signals resulting from engineering, biological and economical structures.

61. GA201/94/1327

Application of Modern Mathematical Methods in Economic Information Processing 1994-1996, Emil Pelikán (main investigator, Dr. Petr Berka University of Economics - co-investigator)

The main aim of this project was to investigate the applications of the most up-to-date methods of artificial intelligence in economy. The theoretical research within the project was oriented on the artificial neural networks and knowledge-based systems. The integration of these approaches resulted in application of developed methods in exchange rate forecasting, credit risk assessment and in other economic areas.

62. ZZ/520/2/97

Photochemical smog prediction and detection in the Czech Republic, 1997-1998, Emil Pelikán (co-investigator, main investigator: Dr. Josef Keder, Czech Hydrometeorological Institute)

The aim of the project was to predict of concentrations of the ground-level ozone and a design of diagnostics of the degree of the danger of emergency atmospheric situations, namely smog-alert states. The investigators used the artificial neural networks and artificial intelligence methods for the development of the forecasting and diagnostic modules.

63. EC TOCOOS Copernicus project, (E+CZ)

CP940247. EC TOCOOS Copernicus project, 1994 – 1996, František Plášil (investigator)

The project objectives were in the development of techniques for the construction of inter-ORB gateways including the design and practical verification of software technology mechanisms for efficient gateways' implementation. The project also aimed to identify a consistent set of primitives to provide generic functionality, necessary for the implementation of various services in open distributed processing. A family of tools has been developed in the form of object-oriented frameworks.

64. GA AS CR A2030902

SOFA (Software Appliances), 1999 – 2001, František Plášil, (investigator)

The project objective is to deliver an integrated software system supporting electronic business and electronic commerce with software, user interfaces, and application software components over a computer network. The system will allow institutions to distribute and trade their application software (i.e. the components) combined with related data via the network instead of distributing it on standard media (e.g. diskettes).

65. AE1030701

Numerical stability of the GMRES method, 1997, Miroslav Rozložník (investigator)

Grant project is devoted to publication of a manuscript devoted to one of the most common method for solving nonsymmetric large sparse systems of linear algebraic equations, to the GMRES method.

66. GA201/98/P108

Numerical stability analysis of iterative methods for the solution of large nonsymmetric linear systems, 1998-2001, Miroslav Rozložník (investigator)

The project deals with an analysis of rounding errors arising during implementation of Krylov space iterative methods for solving large and sparse systems of systems of linear algebraic equations in finite precision arithmetic. The project assumes most of all analysis of rounding errors for implementations of nonsymmetric Krylov space methods.

67. Barrande No. 970109

Modelling of motion control by neural networks, 1997-1998, Stanislav Řízek

Research of new structure of motion control. Utilization of neural networks in design of control systems. Design of program model and simulation of multielement manipulators.

68. NSF Grant INT-9218024 (E)

Iterative Methods for Nonsymmetric Linear Systems and Eigenvalue Problems, June 1993-June 1996, Zdeněk Strakoš (joint project with Anne Greenbaum)

The project is devoted to the problem of convergence of one of the most popular Krylov solver for nonsymmetric linear algebraic system: the GMRES method.

69. IAA230401

Numerical methods for linear algebraic systems with application to nonlinear problems, 1994-1996, Zdeněk Strakoš (investigator)

The basis of the project is to analyze and develop new direct and iterative methods for solving linear algebraic systems of linear equations arising in many fields of scientific computing. A special attention is devoted to Krylov space methods and their possible generalizations.

70. IAA2030706

Preconditioned iterative methods for systems of linear algebraic equations, 1997-1999, Zdeněk Strakoš (1997-1998), Miroslav Tůma (1998-1999) (investigators)

The project includes topics covering theoretical and practical properties of the Krylov space iterative methods preconditioned by various preconditioners, especially those which are useful for solving the problems on parallel computers. A special attention is devoted to questions concerning stability of the methods as well as to an analysis of the behaviour of the methods in finite precision arithmetic.

71. CNR Italy-Czech Ministry of Education Grant:

Iterative methods for Solutions of Linear Systems, PI Mario Arioli and Zdeněk Strakoš, 1998-2001.

This grant is devoted to solving the symmetric and indefinite linear algebraic systems arising in many applications. One of the main motivations are the problems of flow in porous media solved with the help of mixed and mixed-hybrid finite element discretization.

72. NSF Grant DMS-9802919(E)

(Applied Mathematics, with Anne Greenbaum): Preconditioned Iterative Methods for Large Linear Systems, Sept. 1998-Aug. 2001, Zdeněk Strakoš

A natural continuation of the previous grant. One of the most class of problems solved in this grant concerns stability of nonsymmetric iterative solvers.

73. IGA MZ 3773 – 3

Prediction of cytostatic treatment induced bleeding using an artificial neural network, 1996–1998, Václav Šebesta (co-investigator)

The main goal of the proposed project is the development of a decision support system based on neural network, to determine from complex patient data when to administer a platelet concentrate transfusion and when it is better to wait with acceptable precision. This will reduce the risk of alloimmunisation of the patient and increases effect of each following transfusion, which may be absolutely required.

74. GA AV CR 2030801

Parallelization of computer processing, 1998 – 2002, Václav Šebesta (investigator)

The project objective is design, analysis and validation of algorithms for parallel processing and evaluation of effectiveness of complicated problems solutions from the area of visualization, medicine, linear algebra, neural network training and stochastic methods.

75. GA 201/97/1070

Inconsistency Resolution Methods for Data/Knowledge Integration, 1997-1999, Július Štuller (investigator)

In the project we studied different inconsistencies occurring in data/knowledge bases integration. We formulated the conditions under which can occur these inconsistencies and proposed basic classification of these inconsistencies. Furthermore we identified various stages in databases integration where it is optimal to discover and eliminate specific types of inconsistencies. We also designed the IFAR methodology for finding, identification and removal of the inconsistencies in databases integration. Finally, the derived RIFAR procedure implementable in different data base management systems (DBMS) can provide, depending on the available tools in the concrete DBMS, a large scale of software support for data / knowledge integration inconsistencies resolution.

76. GA201/93/0067

Mathematical Models of Underground Water Flow and of Transport of Dissolved Substances for the Purpose of Remediation of Consequences of Uranium Mining in the Northern Bohemia, 1993-1995, Miroslav Tůma (co-investigator)

The project was devoted to mathematical modelling of porous media flow, its mathematical analysis and application of the results to the problem of uranium leaching and real site remediation.

77. GA205/96/00921

Mathematical Models of the Transport and the Reactions of the Chemical Substances in the Contaminated Underground Water, 1996-1998, Miroslav Tůma (co-investigator)

The project deals with the transport of contaminants in the area of Stráž pod Ralskem where hundreds of tons of sulphuric acid were injected into the underground. Basic results cover the whole field from problem formulation, via mathematical analysis of the model up to application to this real-world problem.

78. GA CR 201/95/0976

HYPERCOMPLEX: Complexity issues in high performance computing, 1995–1997, Jiří Wiedermann (investigator)

The main goal of this project is to increase a theoretical background of High Performance Computing by identification, development, investigation and solution of general problems, which can be formulated in the frames of computer complexity theory.

79. OK 304 (E+CZ)

ALTEC-KIT Algorithms for future technologies - keep in touch, MŠMT, 1997–1998, Jiří Wiedermann, (investigator)

The subject of Czech part in this international project is development of theoretical background in relation with the new information technologies. Our research will be focused mainly to the design of sequential, parallel and distributed algorithms and computing models with respect to their effectiveness.

80. GA CR 201/98/0717

Computational models and complexity of computations, 1998–2000, Jiří Wiedermann, (investigator)

The project objective is development of computing complexity theory. Both, general and limited computing models will be investigated and their computational and descriptive power will be evaluated.

81. JEP 4358 (E)

Education in the methodology of health care, 1993-1995, Jana Zvárová (principal investigator) (TEMPUS-PHARE project, without support of the state budget)

The programme was designed to introduce the methodology disciplines of health care, i.e. medical informatics, statistics and epidemiology to the Czech Republic and other Central and Eastern European countries. The programme was developed in cooperation of Charles University First Faculty of Medicine, Third Faculty of Medicine, Faculty of Medicine in Pilsen, Faculty of Medicine in Hradec Kralove, Faculty of Mathematics and Physics, General Faculty hospital in Prague and Academy of Sciences, Institute of Computer Science with 11 EU universities and institutes. The main targets of the programme were to create curricula and courses for European education in Medical Informatics, Statistics and Epidemiology (EuroMISE)

82. GA ČR313/93/0616

Construction of methods for data analysis in epidemiological studies, detection of risk factors and disease risk modelling, 1993–1995, Jana Zvárová (principal investigator)

The main aim of the project was to contribute to the development of methods suitable for analysis of data from epidemiological studies, searching for risk factors and disease risk modeling. Data from the field of oncology and immunogenetics were analyzed.

83. OK 256 (E+CZ)

Managing Uncertainty in Medicine – Information theoretical and statistical approach, 1996–1996, Jana Zvárová (principal investigator)

Research focused on development of the interdisciplinary research in biomedical data analysis. Data reduction and constitution problems, decision support methods and information theoretic approaches in managing uncertainty in medicine and health care were studied/

84. OK 188 (E+CZ)

Information Technologies Education and Training IT EDUCTRA, 1996–1998, Jana Zvárová (principal investigator)

Period: The research focused on development of the new educational materials using new information technologies and on adaptation and translation of educational materials developed in EU countries. Moreover dissemination of the educational materials in courses, conferences and workshops has been running.

85. IGA MZČR 3792 – 3

Polymorphism of candidate genes of subjects from hypertensive families, of their parents and siblings, 1996–1998, Jan Peleška, Jana Zvárová (principal investigator)

Essential hypertension has a polygenic type of heredity. Polymorphism of genes for angiotensin-converting enzyme and angiotensinogen was studied using mathematical and statistical approaches. DNA from leucocytes of examined normotensives from EH and normotensive families was analyzed.

86. IGA MZČR 4038 – 3

Longitudinal twenty years follow up of men with risk factors of atherosclerosis influence of intervention on morbidity and mortality, 1997–2000: Marie Tomečková, Jana Zvárová (principal investigator)

The study of risk factors of atherosclerosis in urban population of the middle age men has been developed. The evaluation of an intervention on occurrence of risk factors, morbidity and mortality is given. Non-invasive detection of ischemic heart disease by a modern method of ECG mapping is analysed.

87. OK 367 (E+CZ)

Integration and Communication for the Continuity of Cardiac Care- TripleC, 1998–1999, Jana Zvárová (principal investigator)

The research focuses on implementation and evaluation of the ORCA system on multimedia workstations and testing of basic assumptions for implementation of these products to hospitals and ambulances.

88. IGA MZČR M-26-3

Mild hyperhomocystenemia in Czech population, analysis of genetic risk factors in patients with atherosclerosis, 1998–2000, Viktor Kožich, Jana Zvárová (principal investigator)

M-26–3

The research focuses of comparison of prevalence of candidate mutations of patients and controls stratified according to the age and sex. There is a deep statistical research focusing on correlation of the atherosclerosis severity in patients with specific genotypes.

89. IGA MZČR M-28-3

Genetic regulation of IgE expression - implication for human atopic diseases, 1998–2000, Marie Lipoldová, Jana Zvárová (principal investigator)

M-28–3

The aim of this project is to map two genes controlling IgE level. The potential benefit of the research lies in better understanding of atopy and risk. Due to high frequency of the disorder of the IgE response the improvement in the effectiveness of its management may result in considerable economic benefits.

90. OK 408 (E+CZ)

Medical Guideline Technology- MGT, 1999, Jana Zvárová (principal investigator)

The research focuses on design and implementation of techniques for computer representation of medical guidelines, which integrate generic recommendations for specific medical circumstances with site-specific conditions.

7 Educational activities

7.a) List of supervised theses.

Master theses

- V. Koubková: Numerical implementation of interior point methods for linear and quadratic programming problems. Master Thesis, Charles University, Prague 1997 (L. Lukšan, advisor).
- J. Macek: Interior point method for large-scale nonlinear programming problems. Master Thesis, Charles University, Prague 1999 (L. Lukšan, advisor)
- J. Hartman: Automatic differentiation in optimization. Master Thesis, Charles University, in preparation (L. Lukšan, advisor).
- P. Kraus: Numerical solution of magnetohydrodynamic equations in two dimension. Master Thesis, Charles University, Prague 1995 (J. Nedoma, advisor).
- M. Novický: Numerical solution of dual contact problem in elasticity. Master Thesis, Charles University, Prague 1995 (J. Nedoma, advisor).
- J. Pristač: Regularity of interval matrices. Master Thesis, Charles University, Prague 1997 (J. Rohn, advisor).
- M. Kovář: Linear interval equations with dependent data. Master Thesis, Charles University, Prague 1997 (J. Rohn, advisor).
- A. Baštová: Numerické řešení nelineární rovnice struktury, MFF UK, Praha, 1995 (J. Nedoma, advisor)

- K. Houšková: Matematické modelování funkce kyčelního kloubu v 3D aproximaci. ZČU Plzeň, FAV, Plzeň 1996 (J. Nedoma, advisor)
- B. Čobanová: Numerické modelování fraktury stehenní kosti v 3D aproximaci. ZČU Plzeň, FAV, Plzeň, 1996 (J. Nedoma, advisor)
- Z. Honzíková: Some contributions to axiomatization of fuzzy propositional calculi, Master thesis on the Faculty of Mathematics and Physics, Charles University, 1999 (P. Hájek, advisor)
- M. Hošek: Odhady vzorové složitosti řešení neuronové sítě na základě analýzy jejich VC dimenze, FNSPI CTU Prague, 1999 (F. Hakl, advisor)
- S. Végh: Vlastnosti Jacobiho matice univalentní vrstevnaté neuronové sítě. FNSPI CTU Prague, 1997 (F. Hakl, advisor)
- K. Jedličková: Application of neural networks in electric load prediction, Faculty of Chemical Engineering, 1997 (E. Pelikán, advisor)
- M. Dostál: Application of neural Networks in statistical data analysis, Faculty of Economics, 1998 (E. Pelikán, advisor)
- J. Musilová: Neural networks in ground level ozone forecasting, Faculty of Transportation, 1998 (E. Pelikán, advisor)
- P. Hrubeš: Traffic flow prediction by Neural networks, Faculty of Transportation, 1998 (M. Novák, advisor)
- T. Chrpa: Traffic flow and occupancy classification, Faculty of Transportation, 1998 (M. Novák, advisor)
- P. Pták: Evaluation of Traffic predictors, Faculty of Transportation, 1998 (M. Novák, advisor)
- M. Hokr: Matematické modelování transportu látek v podzemních vodách, Master Thesis, TU Liberec, 1999 (J. Maryška, advisor)
- O. Severýn: Matematické modelování proudění v porézním prostředí, Master Thesis, TU Liberec, 1998 (J. Maryška, advisor)
- D. Bálek: Relationship Service in CORBA, Master thesis, Charles University, Prague, 1996 (F. Plášil, advisor)
- Nguyen Duy Hoa: Datastore on CORBA, Master thesis, Charles University, Prague 1996 (F. Plášil, advisor)
- S. Hrinko: LifeCycle Service in CORBA, Master thesis, Charles University, Prague 1996 (F. Plášil, advisor)
- D. Mikušík: Implementation of Synchronization Protocols, Master thesis, Charles University, Prague 1998 (F. Plášil, advisor)
- J. Alexander: CORBA Security Service Implementation, Master thesis, Charles University, Prague 1998 (F. Plášil, advisor)
- A. Novák: Transactions in SOFA/DCUP. Master thesis, Charles University, Prague 1999 (F. Plášil, advisor)
- J. Gergič: A Versioning Model for SOFA/DCUP Architecture. Master thesis, Charles University, Prague 1999 (F. Plášil, advisor)
- D. Štrupl: Parallel implementation of neural networks learning, Master thesis, Charles University, Prague, 1996 (R. Neruda, advisor).
- M. Žiaran: Learning algorithms of Kohonen networks, Master thesis, Czech Technical University, FJFI, 1996, (R. Neruda, advisor).
- M. Krob: Parallel genetic algorithms, Master thesis, Charles University, Prague, 1998 (R. Neruda, advisor).
- P. Krušina, Hybrid methods of artificial intelligence, Master thesis, Charles University, Prague, 1999 (R. Neruda, advisor).
- M. Stránský: Artificial Life, Master thesis, Charles University, Prague, 2000 (R. Neruda, advisor).
- D. Šilar: Computer simulation of pottery dissipation processes. Master thesis, Charles University, Prague, 2000 (R. Neruda, advisor).
- M. Mazný: Integration of Rule-Based and Neural Network Approach to Neural Expert System Design, Master thesis, Charles University, Prague 1995 (J. Šíma, advisor)
- J. Červenka: Constructive Learning in Feedforward Neural Networks, Master thesis, Charles University, Prague 1996 (J. Šíma, advisor)
- M. Šorel: Computational Power of Analog Neural Networks, Master thesis, Charles University, Prague 1999 (J. Šíma, advisor)
- O. Martínek: Nonlinear Optimization in Neural Network Learning, Master thesis, Charles University, Prague 2000 (J. Šíma, advisor)

- P. Holomková: Application of Neural Networks in Hop-Growing, Master thesis, Masaryk University, Brno 2000 (J. Šíma, advisor).
- D. Kocmanová: Influence of genetic risk factors on the origin and development of selected diseases, Faculty of Mathematics and Physics, Prague 1999 (J. Zvárová, advisor)
- J. Kolářková: Stochastic methods of individual identification based on genetic information, Faculty of Mathematics and Physics, Prague 2000 (J. Zvárová, advisor)

PhD dissertations (or equivalent)

- Z. Kestřánek: Numerical Analysis 3D Contact Problem of the Signorini Type with Friction in Thermoelasticity. H-Version of the Finite Element Approximation. Ph.D. Thesis, Institute of Computer Science, Czech Academy of Sciences, Prague 1999 (J. Nedoma, advisor).
- J. Kloučková: Optimization problems with inexact data. Ph.D. Thesis, Charles University, Prague 1996 (J. Rohn, advisor).
- J. Daněk: Dissertation under preparation, University of West Bohemia, Pilsen (J. Nedoma, co-advisor)
- Dissertation under preparation: Z. Honzík, since 1999 (P. Hájek, advisor)
- R. Neruda: Functional equivalence and genetic learning of RBF networks, CSc. Dissertation, 1998 (V. Kůrková, advisor)
- M. Rozložník: Numerical stability of the GMRES method, FJFI, 1997 (Z. Strakoš, advisor)
- J. Drkošová: Ortogonalita v metodach Krylovskych podprostoru, FJFI, 1998 (Z. Strakoš, advisor)
- P. Tůma: Persistence in CORBA. Ph.D. thesis, Charles University, Prague, 1997 (F. Plášil, advisor)
- J. Kleindienst: The Bean Channel: Java distributed event model. Ph.D. thesis, Charles University, Prague, 1998 (F. Plášil, advisor)
- D. Zapletal: Application of Neural Networks in Expert Systems, Ph.D. thesis, Charles University (F. Plášil, advisor)

Finally, in the years 1995-1999 the doctoral students M. Štefek, R. Rosendorfská, H. Pikhart, P. Hanzlíček of Faculty of Mathematics and Physics of Charles University were supervised by J. Zvárová and J. Svatoš by J. Jurečková. T. Pilčík of Faculty of Natural Sciences was supervised by J. Zvárová.

Dissertations in preparation:

- D. Prochazka 1998–2000 (L. Andrej, advisor)
- M. Rydvan 1997–2000 (L. Andrej, advisor)
- M. Měříčková 1997–1999 (D. Húsek, advisor)
- P. Žák, ICS AS CR, 1998–2000 (M. Jiřina, advisor)
- Z. Petrová, MFF UK, since 1999 (R. Neruda, advisor)
- P. Krušina, MFF UK, since 1999 (R. Neruda, advisor)
- M. Beran, MFF UK, since 1997 (J. Wiedermann, advisor)

Habilitations, professor nominations obtained degrees

- J. Nedoma: Mathematical modelling in biomechanics. Bone and vascular-implant systems. Habilitation thesis, Institute of Computer Science, Czech Academy of Sciences and University of West Bohemia, 1995.
- P. Hájek: Professor of the Charles University, Prague 1998
- P. Klán: Doc. - Automatic Control, 1999, University of Pardubice.
- V. Kůrková: DrSc. - 1999, ICS.
- R. Neruda: CSc - 1998, ICS
- M. Novák: Doc - Faculty of Transportation, 1999
- Z. Strakoš: Doc. Applied Mathematics, FJFI, 1997
- M. Rozložník: Dr. - FJFI, 1997
- J. Drkošová: Dr. - FJFI, 1998
- J. Wiedermann - habilitation, Parallel and Cognitive Computing, Faculty of Mathematics and Physics, Charles University, 1999.
- J. Šíma: RNDr., MFF, 1999
- J. Zvárová. Prof. (Charles University 1999), Doctor of Sciences (Academy of Sciences 1999)

7.b) Accredited doctoral programs

The Institute has got accreditation for the following doctoral programs – in cooperation with the Faculty of mathematics and physics of the Charles University:

I1 – Theoretical computer science

I2 – Software systems

M1 – Algebra, number theory and mathematical logic

M6 – Scientific and technical computations.

Accreditation for doctoral programs in cooperation with Czech Technical University is in negotiation.

The following programs are proposed for accreditation:

Faculty of nuclear physics and engineering

- Mathematical engineering

Faculty of electrical engineering

- Artificial Intelligence
- Informatics and Computer Techniques

7.c) Universities where the employees of the institute teach.

Charles University:

Faculty of mathematics and physics

D. Bálek, M. Bešta, P. Hájek, R. Janeček, L. Lukšan, R. Neruda, F. Plášil, R. Pospíšil, P. Savický, J. Šíma, A. Štědrý, J. Zvárová, S. Žák, J. Wiedermann, A. Říha, P. Hanzlíček, V. Přibík

Philosophical faculty

P. Savický

1st medical faculty

J. Zvárová, A. Říha, P. Hanzlíček, V. Přibík

3rd medical faculty

J. Zvárová, A. Říha, P. Hanzlíček, V. Přibík

Medical Faculty Pilsen

L. Pecen

Faculty of natural sciences

J. Zvárová, J. Svatoš

Czech Technical University:

Faculty of nuclear physics and engineering

J. Drkošová, P. Hájek, F. Hakl, M. Holeňa, J. Rohn, M. Rozložník, V. Šebesta, Z. Strakoš, J. Štuller, M. Tůma

Faculty of electrical engineering

M. Jiřina, I. Kramosil

Faculty of engineering

P. Klán

Faculty of transportation

M. Novák, E. Pelikán, V. Šebesta

Masaryk institute of advanced studies

V. Šebesta

Masaryk University Brno:

Faculty of informatics

F. Plášil, V. Šebesta, J. Šíma

University of West Bohemia:*Faculty of applied sciences*

J. Nedoma

Medical faculty

L. Pecen

University Pardubice:

P. Klán

Technical University Liberec

J. Maryška

ETH Zurich:

M. Rozložník

Technical University Vienna:

P. Hájek

Wayne State Univ. Detroit:

F. Plášil

Emory University

Z. Strakoš

Survey of extent of lecturing (courses and seminars)

Year	1995	1996	1997	1998	1999
No. of hours	1346	1214	1302	1451	1649

Table 9: Hours of lectures and seminars per year.

8 International activities

8.a) List of international cooperation

The Institute is the founding member of CRCIM – Czech Research Consortium for Informatics and Mathematics (further members being the Institute of Information Theory and Automation of AS CR, Faculty of Mathematics and Physics of Charles University and Faculty of Informatics of Masaryk University Brno. CRCIM is a member of the European Consortium ERCIM, J. Wiedermann is the director of CRCIM. On general, there are not many formal bilateral cooperative agreements on cooperation with foreign institutions (the agreement with the Mathematical Institute of Slovak Academy of Sciences may serve as an example); but the informal cooperation with many foreign institutions (visits, joint papers etc.) is very vivid – see below.

Participation in joint EU projects (cf. The list of research grants and projects, 6bc above):

- COPERNICUS — High performance in geosciences, 1995 – 1999
- COST Action 15 — Many-valued logic for computer science applications, 1995 – 1996
- COPERNICUS — MUM: Managing uncertainty in medicine 1995 – 1996
- ESPRIT Jessi Comun Framework 1996 – 1998
- BARRANDE (Czech-French projects) 3 projects 1997 – 1998
- COPERNICUS Instruments for adoptive control
- Cooperation with CERN — Czech part 1997 – 1999
- NSF — 2 grants joint with an America partner 1995-6, 1998-9
- CNR Italy — joint grant with an Italian partner 1998-9
- COPERNICUS — TOCOOS project 1995-6
- COPERNICUS — ALTEC – Keep in touch project 1997-8

- ESPRIT Project Parasil (programming environment for parallel sparse matrix solves 1998)
- TEMPUS — PHARE project Education in the methodology of health care 1995

List of partner institutions abroad:

- DMSIA University of Bergamo Italy (E. Spedicato),
- DEECS Northwestern University Illinois (J. Nokedal),
- DM University of Namur Belgium (P.L. Toint).
- DMIT University of Jyväskylä Finland (M. Makela, M. Miettinen),
- DM University of Erlangen-Nürnberg (J. Zowe).
- FMI University of Nijmegen Netherlands (O. Axelsson),
- FSA Service de Metrologie Nuclear Bruxelles (R. Beauwens),
- CICT BAS Sofia (P. Vassilevski)
- Indian School of Mines, Dhanbad, India
- NGRI, Hyderabad, India
- CMRI, Dhanbad and Roorkee, India
- Institut de Recherche en Informatique Toulouse (D. Dubois, H. Prade and others)
- University of Gent (E. de Kerre, B. de Baets and others)
- Laboratoire B. Pascal, Université Paris (B. Bouchon-Meunier).
- Univ. of Milano, Italy (D. Mundici)
- Univ. Of Siena, Italy (F. Montagna)
- Institute of Investigation in Artificial Intelligence, CSIC Spain (F. Esteva, L. Godo)
- Univ. Of Vienna (M. Baaz, N. Gottlob, E. Leitsch)
- Georgetown University, USA (P. C. Kainen, A. Vogt)
- Università di Genova, Italy (M. Sanguineti)
- Warsaw Technical University, Poland (B. Beliczynski)
- Austrian Academy of Sciences, Austria (M. Fischer)
- Dept. of Math. Engn the University of Tokyo, Tokyo, Japan (Prof. K. Aibora)
- Division of Biology, CALTECH, Pasadena, USA (Prof. Ch. Koch)
- London Business School (prof. Derek Bunn)
- University of Lisbon in Portugal (Dr. Antonio Rodriguez from Dept. of Statistics and Operational Research, Faculty of Sciences)
- University of East Anglia, Norwich (Dr. Steve Dorling).
- University of Washington, Seattle (Greenbaum)
- Helsinki University of Technology, Helsinki (R. Kouhia)
- McGill University, Montreal (Paige)
- CNR Pavia, Pavia (M. Arioli)
- Cerfacs, Toulouse; LANL, Los Alamos (M. Benzi)
- ETH Zurich, Zurich (M. Gutknecht)
- Linköping University, Linköping (Björck)
- NCSU, Raleigh (Meyer and J. Haws)
- LANL, Los Alamos (J. Cullum)
- Utrecht University
- University of Amsterdam,
- Comenius University, Bratislava
- Erasmus University, Rotterdam
- Limburg University, Maastricht
- CardioControl, Rotterdam
- Ruprecht-Karls University of Heidelberg
- German Cancer Institute, Heidelberg
- MEDIS Institute, Neuherberg
- Phillips University, Marburg
- University of Thessaloniki
- Fundesco, Madrid
- Slovak Institute of Cardiovascular Diseases, Bratislava
- University of Bordeaux
- University of Maastricht, Institute of Science and Technology
- Open University, Milton Keynes

8.b) Membership and positions in international organizations

- AMS — American Math. Society (J. Nedoma, J. Rohn, L. Andrej, Z. Strakoš, M. Fiedler)
 - SIAM — Society for industrial and applied mathematics (L. Lukšan, Z. Strakoš, M. Fiedler)
 - IMACS — Technical committee of Numerical Methods in Mechanics, Biomechanics and Geomechanics (J. Nedoma – member)
 - ILAS — International Linear Algebra Society (J. Rohn, Z. Strakoš, M. Fiedler)
 - GAMM — Gesellschaft für Angewandte Mathematik und Mechanik (J. Rohn)
 - Math. Gesellschaft in Hamburg (J. Rohn)
 - IUHPS/DLMPS — International Union of History Philosophy of Science – Division Logic, Methodology and Philosophy of Science (P. Hájek 1995-1999 1st vicepresident)
 - New York Academy of Sciences (L. Andrej)
 - IFIP — International Federation of information Processing (M. Jiřina – member of Czech representation)
 - IASC — International Association for Statistical Computing (E. Pelikán, K. Eben)
 - Kurt Gödel Society (P. Hájek, president)
 - Int. Institute of Forecasters (E. Pelikán)
 - IEEE (E. Pelikán, F. Plášil)
 - Int. Neural Networks Society (E. Pelikán)
 - ERCIM — European Research Consortium for Informatics and Mathematics (J. Wiedermann – member of Board of Directors)
 - ACM — Association for Computing Machinery (F. Plášil – member of Advisory Board for Central and Eastern Europe)
 - European Association for Theoretical Computer Science (S. Žák)
 - Society for System Science in Health Care (J. Zvárová – member)
 - IMIA — International Medical Informatics Association (J. Zvárová – representative of the Czech Republic)
 - European Federation for Medical Informatics (J. Zvárová – repres. Of Czech Rep., member of a working group)
 - Biometric Society (J. Zvárová)
 - EATC– European Association for Theoretical Computer Science (J. Wiedermann - vicepresident)
- **Long term visits by foreign scientists**
 - Dr. George Darbellay , Switzerland - 2 years stay in ICS
 - J. Brandts, from University of Utrecht stayed here 5 month 2/1999-6/1999
 - A. A. Frolov, Moscow, Russia, 1995 – 1999, 20 month in total

8.c) Long term visits abroad (research and teaching)

L. Lukšan:

- DMSIA University of Bergamo, Italy, 1997, 1999

M.Holeňa

- July 1993 – November 1995, University of Paderborn, Germany
- May 1995 – November 1998, University of Magdeburg, Germany

L. Andrej:

- The Japanese MONBUSHO Fellowship for two months in 1998 (March 1, 1998- April 30, 1998) at the University of Tokyo with Profs. S.I. Amari and K. Aihara. Working on chaotic neural networks.

P. Klán:

- Sept. 1998 - July 1999: Catholic University Louvain, Belgium, research assistant, Suboptimal PID Control.

V. Kůrková:

- COBASE National Academy of Sciences, Department of Mathematics Georgetown University, USA, 3 months, 1997.

R. Neruda:

- 1995-1996: Los Alamos National Laboratory, research assistant, evolutionary computation & neural networks, application to fraud detection (with Mastercard)

M. Paluš:

- a long term stay 6 months in 1996 School of mathematics Queensland University of Technology, Brisbane, Australia

- 1998 6 weeks Isaac Newton Inst. Cambridge University.
- K. Eben:
- a stay in the academic year 1995/96 in Westlakes Research Institute, Cumbria, England.
- Z. Strakoš:
- Emory University, Atlanta, 1995, 1998-1999
- M. Rozložník:
- ETH Zurich, 1998-1999
- M. Tůma:
- Cerfacs, Toulouse, periodically in 1998
- J. Šíma:
- Department of Mathematics, Faculty of Mathematics and Natural Science, University of Jyväskylä, Finland. 1997, 1999 (2x 1 month)
- L. Kodým:
- Department of Mathematics, Faculty of Mathematics and Natural Science, University of Jyväskylä, Finland. 1998 - 2000,
- F. Plášil:
- Department Informatique, Institut national des Telecommunications, Evry, France. Dec 1994 – Jun 1995:
 - Wayne State University, Detroit, U.S.A. Aug 1999 – May 2000:
- R. Rosendorfská:
- Westlakes Research Institute, Cumbria, England, academic year 1995-96

8.d) International meetings organized by the institute

1995

PASE'95 Parallel applications in Statistics and Economy (Trier, Germany) ICS co-organizer
 MFCS'95 Mathematical Foundations of Computer Science – ICS organizer

1996

Gödel'96 Brno – ICS co-organizer
 IEEE European Workshop Neuro-Fuzzy and Neuro-Net 1996 – ICS main organizer
 Prague Mathematical Conference 1996 – ICS co-organizer

1997

WUPES'97 (Workshop on uncertainty processing in expert systems) – ICS co-organizer
 PASE'97 Mariánské lázně – ICS main organizer
 Czech-American Workshop on iterative methods and parallel computing Milovy 1997 – ICS organizer

1998

Modelling'98 Prague – ICS main organizer
 Logic Colloquium'98 – ICS main organizer

1999

COST Action 15 final workshop 1999 – ICS organizer
 ICALP'99 – Int. Colloquium on Automata, Languages and Programming Prague – ICS organizer
 International workshop "The New Millenium: Multinational Solutions to Future Infromation Society", Prague, April 15th 1999.
 Working conference with the intrernational participation "Medical Guidelines in Cardiology", April 16th 1999.

1995 – 1999

SOFSEM'95, 96, 97, 98, 99 – ICS organizer
 Five scientific meetings in conection with the European project IT EDUCTRA, MGT and TripleC during th years 1995-1999,
 International EuroMISE courses, Prague, one month,, 1995, 1996, 1997, 1998 for 20 participants from central and eastern European countries

Besides, the Institute's people served as member of organizing and/or program committees of numerous further international conferences

8.e) International Awards and Prizes

J. Brants: Babuška Prize, 1999

P. Hájek: Honorary Professor of Technical University Vienna.

M. Fiedler: Golden award of J. Hronec, Slovak Academy of Sciences, 1996.

M. Rozložník: Babuška prize (2nd place) for the best work in computer science submitted by students and young scientists, 1996 for the work Numerical Stability of GMRES, awarded by the Czech Association for Mechanics and the Union of Czech Mathematicians and Physicists, December 1996.

J. Šíma, R. Neruda: Young Scientist Prize of Academy of Sciences of the Czech Republic for Monograph: Theoretical Issues of Neural Networks, 1998

V. Šebesta: Award for the best presentation on IJCNN'99, Washington, D.C., USA, 1999

J. Zvárová, P. Hanzlíček, K. Zvára: Award (2nd place) for the best poster at the conference MEDNET'98 UK

J. Zvárová: Award for medical informatics achievement, Erasmus University, Medica Informatics Institute, Rotterdam. Netherland 1999; Award Honorary Membership of Grigore C. Moisil Foundation for Applied Informatics, Sibiu, Romania, 1999

9 Contracts of Cooperation with non-research organizations orders/commissions of the main activities

1995

- ICCC Ltd. – Programming and consultation activities in the sphere of computer networks; 200 hours p. m., 500 CZK p. h. - altogether 1,200,000 CZK in 1995.
- Teledin – Programming in the area of UNIX operation system; 50 hours p. m., 500 CZK p.h. – altogether 300,000 CZK in 1995.
- FCC Folprecht – Development of software in the sphere of neuron networks, programming and application programs for concrete applications; 100 hours p. m., 500 CZK p. h. – altogether 600,000 in 1995.
- SINCO Group joint-stock company – Cooperation in the developing of software products in consultation form; 60 hours p. m., 500 CZK p. h. – altogether 300,000 in 1995.
- IDG – Cooperation in editing the NNW Journal; lump sum 5,050 CZK p. m. – altogether 61,000 CZK in 1995.
- West-Czech Energy Plants – Development of prediction models for electric energy consumption; the stipulated price of the handed-over work was 70,000 CZK for the year 1995.

1996

- ICCC Ltd. – Programming and consultation activities in the sphere of computer networks; 234 hours p.m. and 500 CZK p. h. until 30/6/1996. On 1st July, 1996, a new contract was signed for the other half of 1996 – lump sum 81,000 CZK p. m. - altogether 1,188,000 CZK in the year 1996.
- FCC Folprecht – Development of software in the sphere of neuron networks, programming and application programs for concrete applications; 100 hours p. m., 500 CZK p. h. plus a lump sum 19,600 CZK – altogether 835,200 CZK in 1996.
- SINCO Group, joint-stock company - Group joint-stock company – Cooperation in the developing of software products in consultation form; 60 hours p. m., 500 CZK p. h. – altogether 360,000 CZK in 1996.
- IDG – Cooperation in editing the NNW Journal; lump sum 5,050 CZK p. m. – altogether 61,000 CZK in 1996.
- Teledin – Programming in the area of UNIX operation system; 50 hours p. m., the contract was terminated in July - altogether 163,000 CZK in 1996.
- West Czech Energy Plants – Development of prediction models for electric energy consumption; the stipulated price of the handed-over work was 30,000 CZK altogether.

1997

- ICCC Ltd. – Programming and consultation activities in the sphere of computer networks; lump sum 81,000 CZK p. m. - altogether 972,000 CZK in 1997.

- FCC Folprecht – Development of software in the sphere of neuron networks, programming and application programs for concrete applications; lump sum 17,100 p .m., + 100 hours p.m., 500 CZK p. h. – altogether 805,200 CZK in 1997.
- SINCO Group, joint-stock company – Cooperation in the developing of software products in consultation form; 60 hours p. m., 500 CZK p. h. – altogether 300,000 CZK.

1998

- ICCO Ltd. – Programming and consultation activities in the sphere of computer networks; lump sum 81,000 CZK p. m. - altogether 972,000 CZK in 1997.
- FCC Folprecht – Development of software in the sphere of neuron networks, programming and application programs for concrete applications; lump sum 17,100 p .m., + 100 hours p.m., 500 CZK p. h. – altogether 805,200 CZK in 1997.
- SINCO Group, joint-stock company – Cooperation in the developing of software products in consultation form; 60 hours p. m., 500 CZK p. h. – altogether 300,000 CZK.

1999

- Prague Gasworks, joint-stock company – Prediction models for predicting the demands of natural gas; stipulated price 70,000 CZK in 1999
- Hydrometeorological Institute – Innovation of prediction models for predicting the maximal concentration of ground ozone on the basis of the results and their operation application; stipulated price 60,000 CZK in 1999
- West-Czech Gasworks, joint-stock company – Feasibility Studies of prediction of natural daily demands for the needs of the dispatchers; 81,000 CZK in 1999
- Central – Czech Gasworks, joint-stock company – Feasibility studies of a temperature maps of the Central – Czech region for the needs of the dispatchers; 81,000 CZK in 1999
- Medicaments, joint-stock company – Advisory services for the conception of web-sites; stipulated price 10,000 CZK in 1999
- ICCO Ltd. – Programming and consultation activities in the sphere of computer networks; lump sum 81,000 CZK p. m. - altogether 972,000 CZK in 1999.
- FCC Folprecht – Development of software in the sphere of neuron networks, programming and application programs for concrete applications; range 100 hours p. m., 500 CZK p. h. + a lump sum 19,000 CZK – altogether 835,000 CZK in 1999.
- SINCO Group Ltd. – Corporation in the developing of software products in consultation form; range 60 hours p. m., 500 CZK p. h. – altogether 360,000 CZK in 1999.

10 Final evaluation of the research plan at the Institute level, including the evaluation of teams dealing with single research areas, and statement of the Institute's Scientific Council

The following final evaluation of the institute's research agenda fulfillment is presented in the structure that closely follows the institutional research plan from Part I. In addition to main achievements within each of the respective research streams we will also mention the institute's departments that participate in the respective research. Moreover, we will also name the outstanding leading individuals that represent the basic creative potential of these departments. It comes as no surprise that in most cases the work and achievements of those persons will be referred to as mentioned in Part II containing the annotated summary of the results related to the research plan

10.a) Basic Research Streams

Within the entire institute's research, basic research streams present a core from which interdisciplinary and applied research is derived. It is therefore of utmost importance that basic research streams correspond fully to current trends in the respective fields or, even better, determine or co-determine the formation of the respective fields. Only in such a case they could represent a frontier research - i.e. a research that pushes the frontiers in the fields at hand by opening new research areas and bringing new insights/twists into old problems.

The latter two properties offer a criterion by which the Institute's achievements in basic research should be evaluated.

Mathematical and logical foundations of computer science

It has been stated in the introduction of Part I that the emergence of new computational paradigms is most easily seen in (mathematical and logical) foundations of computer science. Within the ICS, this is documented mainly by the work of two departments: Department of Knowledge-Based Systems and Department of Theoretical Informatics.

In the first one, among other matters firm mathematical foundations of fuzzy logic have been established. This research pioneered by Petr Hájek has achieved a worldwide recognition as documented e.g. by the number of citations of his work and no doubts that Petr Hájek is counted among pacemakers in the field at hand. Alternative mathematical models and methods for uncertainty quantification and processing present the next area under investigation in this department. Along these lines the results by Ivan Kramosil on probabilistic analysis of Dempster-Shafer theory and on Boolean-like interpretation of possibilistic measures should be mentioned. In its domain the respective research reaches the standard level as proved by publications in top-level journals and in widely recognized conferences. The research in theoretical principles of data mining (based on earlier original achievements concerned with so-called GUHA method) also points to progressive streams within department's research.

The essence of the frontier research done in the Department of Theoretical Informatics can be briefly subsumed under the headline of 'non-standard' computational models. Here, especially the research in complexity of neurocomputing (headed by Jiří Šíma and Jiří Wiedermann) achieves international standards. Within the related field of cognitive computing new research direction devoted to algorithmic mind modeling and to complexity of interactive computations has been coined by J. Wiedermann. There is also an ongoing research in the classical fields of complexity theory, such as branching programs, Boolean complexity, or Turing machines. The results of the respective school (represented by P. Savický, S. Žák and J. Wiedermann) often represent the best achievements in the corresponding fields.

Both departments have numerous cooperative links mainly to foremost European institutes involved with a similar research and many results are joint results with the researchers from these institutes. Nowadays, a tighter cooperation between the two departments is in sight. The common denominator of their scientific interests is the so-called soft computing which basically is a fusion of nature-based approaches to reasoning (e.g. via fuzzy logic) and computing (e.g. via neural nets, genetic algorithms, etc.). Soft computing also presents a hot contemporary paradigm in current computer science research.

As an indicator of the high international reputation of basic research departments their frequent entitlements to organization of annual meetings of on-going series of renowned European conferences (such as MFCS - Mathematical Foundations of Computer Science, ICALP - International Colloquium on Automata, Languages and Programming Languages, Logical Colloquium) or single-occasion conferences (such as Goedel Conference, etc.) are to be stressed.

Scientific Computing and Mathematical Modeling

Within the above mentioned basic research stream the respective investigations are performed in two departments: Department of Nonlinear Analysis and Optimization and Department of Applied Linear Algebra.

The first department subsumes the following main activities: development of numerical methods for large-scale optimization and nonlinear programming, non-smooth analysis and optimization (with Ladislav Lukšan being the motor of the respective research), and mathematical modeling and numerical solution of problems in geosciences and biomechanics (centered at Jiří Nedoma). Both scientists are renowned personalities in their fields of specialization. As compared with the previous evaluation the scientific output (measured in terms of high-quality publications) of the department has improved tremendously and nowadays is achieving an excellent international standard. The topicality of the research corresponds to highest current demands in the field - viz. looking for new, efficient and practical methods for solution of both new and classical problems in computational mathematics. The on-going long-term initiative of L. Lukšan in building a library of high-quality numerical programs for universal functional optimization (called UFO) is especially appreciated. Nevertheless, a better marketing of this product is advisable.

The strength of the Department of Applied Linear Algebra is in its long-term concentration to classical problem in linear algebra - viz. the solution of systems of linear equations, matrix problems, etc. What makes the respective research highly up-to-date is its focus onto large and sparse systems, numerical stability and rounding errors, and its equal attention paid both to theoretical and practical issues. The team profits from a tight collaboration with world leading scientists in the field at hand. Undoubtedly, Miroslav Tůma and especially Miroslav Fiedler and Zdeněk Strakoš belong among world specialists in

the field who co-determine the trends in the field. There are also promising young scientists involved (Miroslav Rozložník in the first row, and Jitka Drkošová). Presently and also in the near past the collaborative spirit (not the scientific production) of the team has suffered somehow from the long-term absence of its leader Z. Strakoš (since 1998 at Emory University, US) and of M. Rozložník (since 1998 at ETH Zurich). However, their stays are approaching their ends (by summer 2000) and it is expected that the experience from the stays will pay off in the domestic environment.

Both departments are heavily engaged in transferring their results to practical applications (see the respective evaluation in Section 3 of this Part). They also participate in organizing important international conferences in the field (e.g. the series of conferences Mathematical Modeling and Computational Methods).

General comments common to both basic research streams

Practically all of above named department's key persons are involved in graduate or postgraduate education at the universities and are active as Ph.D. advisors. The respective universities are Charles University, Czech Technical University and University of Western Bohemia. Nevertheless, in spite of intensive efforts the respective teams are lacking in young scientists. The respective reasons are still beyond the power of the Institute and are discussed in a greater detail in Part V section C.

For many years, basic research departments are running specialized weekly seminars: one in applied logic (lead by P. Hájek), one in complexity theory (J. Wiedermann), and one in scientific computing (Z. Strakoš). All these seminars made it among topmost Prague seminars and are very often hosting foreign speakers.

10.b) Interdisciplinary research

On one hand, interdisciplinary research within the ICS profits from its tight contact with the related basic research mentioned in the previous section. On the other hand, people in the respective departments seek actively opportunity for applying their know-how in various areas, such as medical informatics, environment protection, physical sciences, earth sciences, economy, etc. Thus, the strengths of the respective departments are in bridging the gap between theoretical foundations of the respective domains and their practical applications.

Neural Nets and Modeling of Complex Processes

Mathematical theory of neural networks, biologically motivated neural networks, potentiality of chaotic dynamics in single neurons and neural networks, and new kinds of neural network applications - these are the main issues under investigation in the Department of Neural Network. The key personality here is undoubtedly Věra Kůrková who belongs among world-leading researchers in the theory of non-linear approximation by (analog) neural nets. Roman Neruda is a young researcher who is interested in genetic computing and its relation to neurocomputing. People from the Department of Theoretical Computer Science often complement this 'theoretical basis' of the department in their publication activities. The rest of the department is oriented mainly towards applications of neural nets. The results achieved usually present applications of concrete networks to concrete problems and thus are of an 'engineering nature' in the best meaning of this word. The respective publications are to be found in proceedings of specialized conferences and only occasionally in applied scientific journals.

Department of Nonlinear Modeling is scientifically active in two broad research domains: in analysis, characterization and prediction of complex non-linear time series, and in applied statistics in medical research. Its personal basis comprises of statisticians, mathematical engineers and physicists. From the viewpoint of publication quality and quantity the prominent position is taken by Milan Paluš, a physicist whose works on detection of non-linearity in real time series pertinent to real-world phenomena have been published in the best physical journals. The work of others, especially that of E. Pelikán related to predictions, and that of L. Pecen and K. Eben related to applied statistics in medical research, is rated highly by the professionals in the respective fields. They publish mostly in proceedings from specialized conferences and in domestic and foreign journals oriented to application domains at hand.

Both departments participate in editing and publishing the scientific journal Neural Network World (edited by M. Novák) published since 1990 by the ICS. Members of the department have publications in this journal. They also have good relations to the Czech Technical University, especially to the Faculty of Transport (giving courses, participating in a joint laboratory and in joint projects).

Medical Informatics

This stream of interdisciplinary research is covered by a single department that from historical reasons is called European Center for Medical Informatics, Statistics and Epidemiology (EuroMISE). It is

specialized in medical informatics and in medical statistics and epidemiology. The existence of this department ranks the ICS among relatively rare, but very well appreciated institutes which are engaged in the field of medical informatics which is a flagship application of informatics in an important domain of emerging information society - viz. the healthcare. By its specialization and range of its activities this department is unique in all Central and Eastern Europe. On one hand, it operates on the basis of extensive and intensive cooperation with the Czech institutes involved with medicine (e.g. with hospitals, faculties, and other research institutes). On the other hand, its human potential and knowledge base is supported not only by other institute's departments (and especially to the Department of non-linear modeling), but also by its relations to similar leading institutes abroad. The EuroMISE momentum stems from its massive involvement in EC grants of 4th Framework programme (e.g. IT EDUCTRA, TripleC and MGT) that enable it to continuously increase its spectrum of activities. The EuroMISE acts as a real pioneer in introducing the information technologies to practice. It is active both in designing, shaping and developing of new tools for some task in the field for extracting relevant information from medical databases (e.g. CORE), for decision knowledge based systems in diagnosis and treatment of hypertension (e.g. HYPERTENSION), new software tools for research in epidemiology (Epitools) and customizing of the multimedia electronic patient record in cardiology (ORCA) to Czech language. However the respective research is also connected with new methods of education and training using new information and communication technologies. Their training activities have a truly international scope: in addition to the Czech Republic, also countries of Central and Eastern Europe are covered. A single person behind is Professor Jana Zvárová whose enthusiasm and scientific and organizational productivity can only hardly be challenged by any other real person. The rest of the department acts mostly as a supporting and realization team of her efforts, however new young researchers (P. Hanzlíček and J. Svatoš), have already shown their abilities to co-operate in research teams with physicians and other health professionals.

General comments common to both interdisciplinary research streams

The strength of interdisciplinary research at ICS is in its versatility and viability. Seemingly effortlessly it looks for interesting and potentially useful applications. The respective departments have usually no problems in obtaining grant support or in being involved into international research consortia. No doubt that these are the signs of their quality in the applied world. In the world of theory, the reserves are seen in the quality of their publications.

Applications

The applications of ICS research results present an integral part of its both basic and interdisciplinary research and therefore there are no extra departments of 'applied' research in ICS organizational structure. Below we mention for each of the research streams the respective applied results.

As far as the stream of computer science foundations is concerned, there are applications especially in the domain of data mining. The respective efforts build on the original GUHA approach rooted in seventies. In the field of applied neurocomputing the work of V. Šebesta and D. Húsek could be mentioned. Another application domain is the area of software engineering. This is an important field in which the ICS tries to build up a research position since mid of nineties. Unfortunately, the success measured in terms of persons is quite modest. So far the Institute succeeded only in hiring a half-time researcher who, however, is a top professional in the field of CORBA technology, object services and component-based systems. František Plášil, a professor of Charles University, is leading a small team of Ph.D. students who have achieved a remarkable success in penetrating with their works to leading US conferences. In European context this is a not-very-often-seen matter. The research in scientific computing is rich with applications. The applications to be named here are especially those of M. Tůma (in cooperation with Liberec University) targeting at environment protection, and those of J. Nedoma in biomechanics and geomechanics. The efforts of J. Nedoma in contributing to the development of computer aided surgery systems (CASS) that allow simulations of surgical procedures on a virtual model before actually performing them on a patient are unique. The CASS belong to the hottest, albeit most difficult topics in current applications of scientific computing.

The results and know-how of people working in interdisciplinary research are still closer to applications. For instance, in neurocomputing there are applications in particle physics and pattern recognition (M. Jiřina and F. Hakl), in complex processes modeling in energetics, transport sciences, banking (E. Pelikán, M. Novák). Applications of statistics in medical informatics have already been mentioned.

10.c) Statement of the Institute's Scientific Council

The internal institute's 'self-evaluation' presented above confirms that the Institute is prolonging successfully its mission started by the beginning of nineties. As compared to previous evaluation period, the Institute has matured in several dimensions: the quality and the quantity of its scientific production has increased as well as the process of the transfer of its knowledge to society. The latter concerns both its influence and share in education and its participation in spreading and applying its scientific results, knowledge and experience. The Institute has agreements with leading Czech universities on joint Ph.D. programs. Among numerous grants also grants and research contracts from industry can be found. Rich network of scientific contacts has been established and utilized for a cooperation. There are ongoing efforts to win EU grants with some of them being successful. Representatives of the Institute participate in important scientific bodies (such as European Research Consortium for Informatics and Mathematics, European Association for Theoretical Computer Science, Goedel Society, editorial boards of renowned scientific journals, etc).

As a result of all these activities the Institute has confirmed its forefront position in the domain of basic research among similarly oriented institutes. In its interdisciplinary efforts it keeps touching the current trends. In general, in its activities the Institute has become more knowledgeable of its own strengths and more focused in achieving its aims as stated in Part I. Similarly, its reputation, both national and international, has aggravated. Increasingly more it is becoming a partner for similarly oriented institutes abroad. In a short, the Institute of Computer Science has set out on its journey towards a center of scientific excellence.

IV Answers to General Questions

1. Describe in key words:

- a) the principal field of research at the Institute**
b) other major activities.

The principal research fields:

- Mathematical and logical foundations of Computer Science
- Scientific computing
- Mathematical modeling
- Neurocomputing
- Modeling of complex processes
- Medical informatics

Other activities:

- Lecturing at universities, supervising Ph.D. studies
- Consulting and auditing
- Cooperation with software and other companies
- Organizing scientific events
- R&D results dissemination
- Scientific mobility

2. What is your opinion on the importance of the Institute and why should it be supported within the framework of national R&D policy?

Within the framework of national R&D policy the Institute of Computer Science, as an Institute of Academy of Sciences of the Czech Republic plays an important role in the field of fundamental research in computer science. In accordance with its founding charter its research is focused mainly to the fields of mathematical and logical foundations of computer science, scientific computing, mathematical modeling, neurocomputing, modeling of complex processes and medical informatics. In these areas the respective research within the Czech Republic is unique as far as its topicality, quality and quantity is concerned. This position of the Institute is generally recognized both at national and international level.

These facts have been witnessed at many occasions in the past. For instance, the previous evaluation of the Institute ended with similar conclusions. To give evidence from near past, one can mention a high rate of interest for Institute's know-how in the recent call for projects dealing with national centers of excellence. In this call the Institute was approached by 5 other leading Czech research institutes or universities in order to cooperate on joint projects. In the role of the principal proposer the Institute itself has submitted 2 such proposals. It also participates or has participated in several international research projects and serves as a partner Institute for similarly oriented foreign institutes.

In addition to its principal research activities the institute also plays a hardly replaceable role in Ph.D. and universities studies and as a center of scientific life and mobility in the Czech Republic, in the respective fields.

As a final argument in favor of national support of R&D in computer science, let us note that computer science, as a fundamental science, undoubtedly belongs among those sciences whose development must be included among priorities in the scientific policy and cannot be left to random or 'market' development. Moreover, this argument is currently amplified by the fact that within the Czech Republic, computer science jointly with mathematics is internationally rated by scientific publication/citation criteria as the most successful science. Last but not least, its role as that of a provider of scientific background of information society development ranks it probably into the first place among sciences which should be increasingly more supported when the Czech Republic should play a distinguished role within the EU joining countries.

3. What is your rating of your organisation in the national and international systems of research? What criteria have you used? Which laboratories/institutes/university departments in the Czech Republic are working on similar topics? Name the top three Czech and three international research institutions working in the same field as your own.

Our rating of the Institute in the national and international systems of research is primary based on the last Academy Evaluation of the Institute in the year 1996 by an international committee of 15 experts in the field of Computer Science. The Institute was evaluated as being among the best institutes within the field of technical and natural sciences institutes of the Academy of Sciences of the Czech Republic. The Institute was found to be on a comparable scientific level as other leading European research institutions in the field. The evaluating committee considered the usual criteria such as scientific achievements, publication activities, organization of scientific events (conferences, workshops and seminars), number of obtained international and national grants, participation at university and Ph.D. studies, international and national cooperation, applications of research results etc. Since the last Institute Evaluation in 1996 the Institute has continued to work hardly to obtain even better results.

An other possible evidence of Institute's good rating and scientific name is offered by the number of published papers, editorials, co-organization of scientific events and obtained grants from different grant agencies like NSF, EC and main Czech grant agencies, on which the Institute researchers participate(d) together with well-know personalities from Europe, in some cases also from United States, and from other Czech research institutions.

The main Czech institutions working on similar (but not identical) topics are:

- Within Academy of Sciences of the Czech Republic:
 - Mathematical Institute (a minor overlap only in topics such as mathematical and logical foundations of computer science, scientific computing)
- Within Czech universities (again only marginally overlapping topics):
 - Charles University, Faculty of Mathematics and Physics, Prague
 - Masaryk University, Faculty of Informatics, Brno
 - Czech Technical University, Faculty of Electrical Engineering, Prague
 - University of Economics, Faculty of Informatics and Statistics, Prague

Top three Czech research institutions working in the same field

- Charles University, Faculty of Mathematics and Physics, Prague
- Masaryk University, Faculty of Informatics, Brno
- Mathematical Institute, Academy of Sciences of the Czech Republic, Prague

Top three international research institutions working in the same field:

- INRIA (Institut National de Recherche en Informatique et en Automatique), France
- GMD (Forschungszentrum Informationstechnik GmbH), Germany
- CWI (Center for Research in Mathematics nad Informatics), the Netherlands

4. How do you estimate the future development of your field of research from point of view of your organisation? Are the main tasks and lines of research, ensuing from the new development, already known to your organisation? What is the role of your organisation in the new development?

Our view of the future development in the field of Computer Science research has been laid down in the Institute Research Plan (see Part I). In this Research Plan our ideas concerning the Institute's mission have been stated in more details. The ultimate goal of this development will be the complete transformation of the Institute into a national center of excellence that will play a role similar to that of the national centers for computer science mentioned in the previous section 3. With respect to the worldwide trends towards information society and national policy aiming at joining the EU in next few years we are quite sure that the role of the Institute in this new development will be constantly increasing.

V Answers to Special Questions

A. On present tasks and activities

5. Have the lines of research mentioned in answers to questions in IV/1 changed in the last five years? If they have, in what way?

The principal lines of research have not changed in last five years. Only more stress to its timeliness to newest trends in particular fields and to reflection of new computational paradigms has been exercised.

6. What is the proportion of R&D in the work of your organization; what is the proportion of other activities (services)? How important do you consider the other activities (services)? Have the proportions of R&D and other services changed in recent years? Why and how? In your opinion, how important are the development, testing and application of new information and telecommunication technologies? (Please specify.)

The overwhelming majority in the work of the Institute is devoted to research, education and organization of scientific life. Unfortunately, the administrative related to such activities (writing grant-proposals and reports etc.) is becoming increasingly more time consuming. The remaining activities (mostly services such as consulting, expertises, auditing reviewing, Ph.D. thesis defending, cooperation with non-research companies, etc.) form a negligible portion of the Institute work. In spite of this we consider these other activities as important ones, and in some cases (especially those related to some economic profit) we would like to increase their overall quantity and quality. In the recent years the proportion of research and other activities/services has remained roughly unchanged. This is mainly due to socio-economic and legal conditions within which the Institute operates. What had changed were the quality of the research and the scope of international cooperation in joint projects. More stress is also put upon marketing of scientific results in scientific community, their popularization and also to their application either within the institute itself or outside of it. There also is a continuous effort towards increasing Institute's involvement in education.

As far as the development, testing and application of new information and telecommunication technologies are concerned, only the experimental development and testing of selected information technologies applies to Institute's mission. See more details about the achievements of the institute in Part III Section 10.

7. Who are the users of the results of R&D activities of your organization? Who are the most important users of the other (non-research) services (activities) offered by your Institute? Do you organize courses for the users of your services?

The primary user of the R&D results of the ICS is the world scientific community, which benefits mainly from the results achieved within basic research streams. In addition to this, the principal users of the results of our interdisciplinary research are some state enterprises (in the field of the environmental protection and remediation), medical centers and hospitals (results of medical informatics research), electric and gas distribution companies and environmental protection agencies (complex processes modeling and prediction), chemical companies (data mining), etc.

As mentioned above, the other (non-research) activities - such as consultations, expertise preparation, etc. — offered by our Institute present but a marginal fraction of its activities. This is due to the fact that such activities are only complementary ones to the Institute's main mission and demand for them is low.

The situation is more interesting on the field of education and training. In addition to the efforts at the filed of postgraduate studies the ICS ids engaged heavily in on-the-job training in the field of medical informatics. Its is the Department of Medical Informatics which has a long-term experience in organizing courses for physicians and students in the field of various domains of informatics applications.

The institute has been also involved in consulting and expertise for various companies and institutions. Some of our researchers act as experts in governmental and international committees. For details see section III.6, page 35.

8. To what extent is your offer of services connected with further training of R&D workers?

The main issue here is the participation of ICS in Ph.D. studies which can be seen as a further training of future R&D workers. In cooperation with universities we offer both extensive and intensive services in this field. Of course, these are non-profit activities. The demand for such services is low due to the low interest for postgraduate studies among young people. The institute is ready to cover much greater demand than the current one.

On the other hand, the Department of Medical Informatics has an elaborated system of on-the job training in the field of medical informatics and it offers courses and services to various users from hospitals, medical research institutes and medical faculties Ph.D. students. The interest for such services is often higher than that which can be satisfied.

9. What was the demand for your organization's non-research activities in the last three years? What prevents potential users from making greater use of the services offered by your organization?

The demand for Institute's non-research activities was minimal in the last three years — in most cases some expertise on bizarre and suspect 'alternative science' proposal by 'amateur scientists'. Besides, the Institute as the basic research institute has neither capacities and in some cases nor the necessary practical know-how that could make such activities economically interesting. Last but not least, the demand for such activities is practically non-existent.

In the wider, non-profit sense, there is an ongoing demand for our experts to serve in different scientific bodies at various universities (e.g. in scientific or examination boards), institutes, governmental institutions (granting agencies), editorial boards, etc.

B. Planning and evaluation of activities

1. Who establishes the guidelines for your organization? What are the roles of director, employees and boards (e.g., Scientific Council) in the planning, co-ordination and evaluation of research?

Respecting the freedom of scientific research:

- The guidelines for the Institute research are frequently discussed and reevaluated in discussions on various levels at various opportunities. First, there are regular weekly meetings of top management, working meetings with heads of scientific departments and scientific department meetings. In parallel to that there are roughly monthly meetings of institute's scientific council in which top management participates. This is complemented by three specialized internal seminars where space for in-depth professional discussions is offered. Recently, there have been introduced autumn and spring extramural two-day workshops open for the whole Institute. The general long-term vision of the Institute (for approximately a decade) is formulated by the director of the Institute in a close cooperation with its scientific council.
- The top scientific management formulates, in cooperation with the Institute Scientific Council, heads of Institute scientific departments and other Institute key scientific personalities, the Research Plan of the Institute for a period between two consecutive institute's evaluations.
- The Institute key scientists influence the main stream of research by formulating long term visions in their respective fields, attracting young researchers around them and writing larger grant proposal. For these personalities the Institute offers its maximal support.
- Individual researchers are free to propose other grants.
- The scientific management of the Institute strives for involvement of the substantial parts of the Institute in every attractive call for large grants, be it at national or international.
- The Institute Scientific Council gives, after judging the over whole quality and correlation with Institute main research streams, its final approval to every proposal of grant and scientific project.

The role of director of the Institute is a fundamental one in the area the planning, co-ordination and evaluation of research. On the beginning of his election period he/she formulates his/her vision of the Institute future for the next four years. On one hand, in cooperation with Institute directorate, Scientific Council and heads of scientific departments the director of ICS has a great and real influence on planning, coordination and evaluation of research. On the other hand, only the director himself has the main responsibility for the fulfillment of the respective tasks.

2. What is the organization's structure regarding research and administration? Is the work (research projects or programmes) exceeding the scope of individual departments (sections) planned? Are other joint R&D activities planned? Please mention projects in which more than one department takes part, with the names of these departments. Is there an internal grant system in your organization?

As mentioned in part V. B. 1) the more detailed orientation of the research is mostly based on individual initiatives of institute's key researchers than on some central planning. However, care is taken that such initiatives match the Institute's scientific interests. This is also true for research projects exceeding the scope of individual departments that, however, require an agreement of all participants. These 'cross-department', or even 'inter-institute' projects of grants are quite common and often give the research the necessary interdisciplinary nature.

The list of selected projects (grants) in which more than one department takes part follows: 11, 14, 44, 45, 74, 78, 79, 80, etc.

The Institute motivates every researcher to actively participate in at least one research project/grant. Therefore, in the last three years there was no necessity for making use of internal grant system of the Institute. However, it can be invoked in case when a good research proposal of some researcher has not been approved by the respective granting agency. In such a case the director in cooperation with the scientific council can decide to support the respective researcher from institutional budgets.

3. Are the activities of your organization regularly evaluated? If yes, what are the form and criteria of evaluation? Who appoints members of the Scientific Council (or boards for other types of services)? How long is their term? Please describe the forms of work of the Scientific Council (or boards for other types of services).

The activities of the Institute are regularly evaluated on several different levels with various periods of evaluation:

- Within the Academy of Sciences of the Czech Republic the Institute was evaluated (similarly as all the other institutes) in the 1996 by an independent international evaluating committee.
- The Institute directorate together with the ICS scientific council evaluates approximately bi-yearly all the scientific departments.
- The Institute directorate together with Institute Scientific Council evaluates approximately yearly all the researchers.

The principal evaluation criteria at all levels remain the same, i.e. publication activities, scientific results/achievements, organization of scientific events, invited talks/papers, pedagogical involvement, projects granted, international and national cooperation, membership in editorial boards, scientific societies, etc.

Usually, the evaluation is done by an evaluating committee, part of the evaluation, and its conclusion, being in the presence of the person under evaluation, or in the presence of a representative of the evaluated group or department.

The Scientific Council of the Institute is elected on a general assembly meeting of all research workers of the Institute. The election period is two years. The council has up to 12 members from which at least one third are scientists not working in the Institute.

The Scientific Council meets regularly bi-monthly and in case of urgent matters whenever necessary. All the Council decision is taken by a majority vote.

4. How does your organization present its work and results to the scientific community and potential users? Who are the principal addressees? Does the organization publish its own periodicals? How does the organization present its tasks and results to the general public? Through which media (audio-visual media, journals, Internet, exhibitions, etc.)?

The principal addressee of the results of Institute's research efforts is the scientific community, students, and the sector of applied research (the latter being presently practically non-existent in the Czech Republic). The principal channels for the Institute work and results presentation to the scientific community are publications in scientific journals and proceedings of conferences, monographs, textbooks and Institute technical reports. Other means are oral presentations at various kinds of scientific events like seminars, workshops, colloquia, conferences, congresses and symposia. In present time the Institute hosts three well-know seminars, open to everybody and organized by renowned scientists in respective fields: Prof. Hájek – Seminar on Applied Logic, Assoc. Prof. Strakoš

- Seminar on Applied Linear Algebra and Assoc. Prof. Wiedermann - Seminar Hora Informaticae – on theoretical computer science).

The ICS publishes bi-monthly the scientific journal Neural Network World (since 1991) in which many Institute's results from the field of neurocomputing and from related fields are published.

Yet another possibility for presenting the Institute is "The Open-Doors Day" organized by the Institute during the "Days of Sciences" in the Czech Republic or by some of institute's departments (such as Department of Medical Informatics). The majority of visitors are university and high schools students.

A paramount example for popularization of computer science in general and Institute's results in particular to a broader professional audience of people working in theory and practice of informatics is Institute's regular participation and support of the series of conferences SOFSEM. This is a series organized since 1974 each year in a row. It is devoted to the current trends in theory and practice of informatics and is visited by people from academia, research and industry, both from the Czech Republic and abroad. Its proceedings are published in Springer-Verlag. J. Wiedermann from ICS serves as the Steering Committee chairman of this series since 1995. Regularly, key scientists from the ICS are invited to present results of their work at SOFSEM.

Some Institute researchers are active in science popularization field for larger professional community, mostly in popular magazines on personal computing. Due to the abstract nature of majority of institute's results or products the media such as TV, radio, exhibitions, etc., are used only rarely.

5. Which results of the organization's research can be applied in the entrepreneurial sphere? Is there a special budget for applications and maintenance of industrial authorship and other rights to intellectual property? How has the organization appraised the amount and structure of funds obtained from third party sources in the last three years? What was the organization's profit from its own activities in the last three years, and what was its income from licenses?

The organization's research, which can be applied in the entrepreneurial sphere comes mainly from applications oriented departments, viz. the Department of Complex Systems Modelling (prediction, time series, etc.) and Department of Neural Networks (various types of artificial neural networks applied to different areas). Furthermore some very modern and attractive methods of data mining are incorporated in well-known GUHA system finding applications in decision support systems. Another example of a program package presents the package of numerical programs named UFO. However, it must be stressed that these packages serve mostly for educational or experimental purposes and that their commercial use has never been envisaged due to the Institute's mission in basic research and Institute's staff professional specialization. The institute has no professionals who will be specialized in commercial programming or in commercial marketing.

Due to the above-mentioned facts at present the Institute does not feel any need to allocate a special budget for application, maintenance of industrial authorship and other rights to intellectual property

The Institute gets between 20-30% of its income from cooperation with and work for third parties. A part of Institute's income stems from letting the offices within the Institute's premises to third parties. The institute does not have any income licenses.

C. Staff, facilities and equipment

1. Please describe and roughly assess the buildings/laboratories/offices and equipment of your organization. Which are the most expensive apparatuses and instruments at the Institute's disposal?

The ICS is located in one building, which is part of the property of the Academy of Sciences of the Czech Republic in Prague 8, Mazanka campus. The building — consisting of 5 levels — is at the same time co-occupied by the library of the Oriental Institute and several IT companies (Sinco, ICCS).

The office equipment is quite standard; the ICS does not possess any special or expensive laboratory instruments or machines. Among more expensive items in the ICS inventory are several workstations, including one Silicon Graphics Origin 200 computer, bought in 1999 (price: 1.7 million CZK). Another more valuable piece of hardware equipment is a cluster of 17 Linux workstations bought in 1999 for 0.4 million CZK. The total value of remaining PC servers and desktops might sum up to another 2 million CZK, but — due to the nature of hardware equipment — its cost vanishes quite fast.

2. Please describe and evaluate the personnel policy of the organization with reference to research and development.

As with almost any research organization in Czech Republic, the ICS is suffering from the lack of new generation of researchers. The situation is getting slightly worse over time, and many of the factors involved cannot be influenced from within the ICS. The discrepancy between salaries in commercial and research domain in IT is huge, which does not motivate young people to stay in (or even consider to come to) the Institute. The highest priority of personnel management is to provide a competitive environment, where good results are recognized, but the resources are limited. The figures from I/2 show that the ICS is aging because until recently we have missed the youngest generation of PhD students.

3. How many positions in respective salary categories are contracted with undefined and defined terms?

See Part I/2

4. Which are the fields of newcomers joining the staff? Was it difficult to acquire or keep experienced researchers in the past three years? How many of your colleagues are tenured university Professors or became heads of R&D institutions and subsequently left the Institute in the past three years?

Recently, ICS has acquired several young researchers from the mathematical logic area, neural nets and adaptive systems, software engineering, and non-linear modeling. There have been only a few experienced researchers that have come to work part time in ICS. At the same time there have been several important departures of mostly young people, either graduates or post-docs, in most cases Ph.D. students not finishing their studies. No researchers left the Institute because of accepting a university professor tenure or for a similar reason.

5. What is the organization's view of its personnel, material and investment funds? In which respect is the budget considered insufficient (if it is)?

Due to the unsatisfactory personnel situation, the ICS management is very flexible in supporting the personnel needs of individual research teams. New positions are being opened quite often, and the Institute wishes to offer young people reasonable salaries. But the personnel part of the budget is very limiting.

The material needs of the Institute are more or less covered and we do not see any big problems in this area.

Investment funds are spent according to the Advisory Investment Board that evaluates all requests. Generally, grant funding covers smaller investment items of research teams (desktop computers, etc.). On the other hand, ICS regularly takes part in the competition for larger investment items within the Academy of Sciences.

D. Support of educational activities, co-operation with companies

1. Does the organization participate in the training of young scientists? If yes, in what manner? How many employees of the organization improve their scientific qualifications (graduate study, preparation for second doctorate, etc.)? What funds are available to graduate students? Does the organization enable employees of other organizations and students to improve their qualifications? From which universities and organizations have most of the graduate students come?

The ICS cooperates with several universities in the training of young scientist. Many ICS researchers are supervising PhD students, and reading lectures for PhD students. Some of our employees are members of respective councils for PhD studies at universities. Our cooperation is especially tight with Faculty of Mathematics and Physics of Charles University and the Faculty of Nuclear Engineering of the Czech Technical University, but we have contracts signed with a dozen of other universities (for details see Part III).

It is quite usual for a graduate student supervised by an ICS employee, to have a part time position in ICS and to be involved in a particular research team. Students take part in a regular research, and present their results during the special ICS PhD Conference organized every year, and/or at ICS seminars.

**2. To what extent does the organization co-operate with:
a) comparable institutions offering infrastructural services to research in this and other**

countries

b) universities in this and other countries

c) non-university research and development organizations in this and other countries

d) industry

e) centers of continuing education

See Part III.

3. *Does the organization participate in joint research projects under the programmes of the European Union? Has it joined in the EU networks?*

Also see Part III.

In the past, ICS research teams have taken part in several EU founded programs, such as Copernicus, COST, Esprit, or Phare. ICS has been part of EU network activities ALTEC and ALTEC-KIT. Recently, we have been awarded a grant within a 5th EU Framework Program. We are constantly submitting proposals to various EU projects, such as Centers of Excellence, 5th FP Future and Emerging Technologies, etc.

4. *Has the organization been taking part in other kinds of intergovernmental bilateral co-operation? If yes, with whom and to what extent?*

ICS has participated on three Barrande projects, and the cooperation between CERN and Czech R&D institutions organized by Ministry of Industry and Business of CR. We regularly take part in intergovernmental mobility grants managed by the Academy of Sciences, where several our researchers succeed each year.

Besides, our researchers take part in the bilateral mobility cooperation organized by the Office of Academy of Sciences.

5. *In which fields and in what form will the co-operation be developed in the future?*

We shall continue in present forms of cooperation and extend it creatively.

6. *Did the organization undergo international evaluation in the past two years?*

No. (Last international evaluation took place in 1996.)