Nizhni Novgorod State University Faculty of Computational Mathematics & Cybernetics



«Information technologies» laboratory

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Nizhni Novgorod

Nizhni Novgorod is the capital of Privolzhsky Federal District (7% of territory, 22% of population of Russia).

"Third capital" of Russia.



Nizhni Novgorod has been founded in 1221 by Yuri Vselodovich.

University of Nizhni Novgorod

www.unn.ru

UNN is the **first state university**, organized in Soviet Union (1918). Nowadays, by official rating of the Ministry of Education, UNN is **among top 10 universities in Russia**

- 27 faculties (departments)
- 122 chairs (subdepartments)
- 6 research institutes
- over 1000 professors
- over 1000 PhD students
- over 26000 students

Nobel Prize winner (2004) professor **Ginzburg** worked at UNN (radiophysics faculty) for more then 20 years



Faculty of Computational Mathematics and Cybernetics

• one of largest faculties at the Nizhni Novgorod State University

- over 1250 full-time (day-time) students,
- over 240 students studying in the evening
- 120 extramural students.
- over 40 Post-graduate students
- Teaching staff includes
 - 30 Professors, Doctors of Sciences in Physics and Mathematics or Engineering
 - 54 Associate Professors, Candidates of Sciences (Ph.D.) in Physics and Mathematics or Engineering
 - 4 professors hold the honorary title of Merited Scientist of the Russian Federation

The Faculty of Computational Mathematics and Cybernetics was founded in 1963 at the Nizhni Novgorod State University as **the first such faculty in USSR.**



Information technologies laboratory

Was established in UNN on the 23th of December 2002 with Intel support

•Lab Human resources:

Number of students (BSc & MSc): 50
Number of students accepted this academic year: 27
Number of applications this year: 120
Number of PhD students: 5
Number of Prof. & Faculty: 20
PhD and doctor of science (%): 65%

•Infrastructure:

Dedicated room: office (312), lab (114, 317), class (310)
Computational cluster (44 procs with 12 dual P3 Xeon, 2 quad P3 Xeon, 12 P4 PCs)
Internet connection 100, 1000 Mbit/s
Research Library (~540 books)



www.itlab.unn.ru

Lab general info

Lab Mission: Curricula development, world-class education and research in Computer Science

Profile & Core Competence: Parallel computing, proactive computing, compilers, optimization, machine learning, software engineering

Collaboration: ITLab is a **unique experience** of the collaboration in advanced university education and research in IT with industry. ITLab collaborates with a number of **leading universities** including Moscow State University, Saint Petersburg State University, University of Cambridge, Zurich Institute of Technology, Saint Petersburg University of Aerospace Engineering. ITLab collaborates also with **software companies** including well-known such as Intel, Microsoft, IBM, Borland and local software companies Telma, Mera



Eidgenössische Technische Hochschule Zürich Swiss Federal Institute of Technology Zurich

Moscow State University











Enhanced Education

- Advanced courses in Computer Science
- Projects based education
- Lab seminars
- Conferences, forums
- Winter and summer schools for young specialists
- Virtuoso project
- Enhanced education program for IT companies specialists
- Academies
 - Microsoft IT Academy
 - Cisco Academy
- Internships several short and long term internships for ITLab staff and students have been granted, including internship in Saint Petersburg University of Aerospace Engineering, Delft University of Technology, Zurich Institute of Technology



ITLab intern Roman Mitin has had internship in ETH (Zurich) in 2004 Picture Niklaus Virt and Roman Mitin

Advanced Courses in Computer Science delivered in ITLab

- Cryptography
- Operational system UNIX
- Quantum calculations
- Programming technologies
- Formal languages and translation method
- Digital signal processing
- Microprocessor architecture
- Algorithms analysis and development
- Other courses



Prof. E. Kruk (S.Petersburg University of Aerospace Engineering) "Cryptography "



Prof. D. Comer Purdue University "Net Processors"



Academician M. Lavrentiev (Novosibirsk University) "Ill-posed problems"



Prof. E. Gordon University of Western Illinois "Quantum Calculations"

Educational IT projects

- Program optimization with MKL and IPP libraries (started 2004, from April 2005 R&D project supported by Intel)
- Cryptograpphy
- Retargetable Simulator
- Research Compiler students of this project are also responsible for .Net compiler within .Net Processor Project supported by Microsoft
- MPI testing
- Open MP support for GCC
- Multicore architectures
- Keys distribution protocols in ad hoc networks
- Others educational projects







Virtuoso Project 2004

- Organized by NNSU, Intel, supported by Intel, Microsoft, IBM, Kaspersky Lab, Borland
- 9 PhD students and associated professors from various Russian and Ukrainian universities/ August-December 2004
- Project participants:
 - have attended 9 courses (216 hours) provided by Intel, Microsoft, IBM, Borland and Kaspersky Lab
 - have gotten a real-life experience at Intel Nizhni Novgorod Lab
 - have also developed a new courseware on software engineering with leading UNN specialists



Enhanced Education Program for Intel engineers

- 83 Intel employees participated
- 35 of them have successfully completed this program
- 15 lectures courses were given (5 of those have been newly developed, 5 have been essentially renewed)
 - Operational system UNIX
 - Algorithms development and analysis
 - Parallel computing
 - Digital signal processing
 - Digital communications
 - Programming with Matlab
 Lecture courses were
 complemented by practices,
 tests, research challenges



Curricula development

- Launching (2003) together with Moscow State University and University of St. Petersburg new speciality "Information Technology".
- Participating in and organizing conference on teaching computer sciences. In particular, ITLab staff participates in conferences of IT education, organized by **AP KIT** and sponsored by leading IT vendors to acquire and share modern knowledge in IT with leading universities and companies. Professor V. Gergel is currently a member of Education Council of AP KIT.
- Implementing CC2001 recommendation in education process
- Developing educational complexes on modern directions of mathematical modeling, computational mathematics and industry technologies of complex software development. One of the major features of educational complex is its modularity, which allows to group different curriculum's configurations according to program requirements and trainee grounding level. Each course includes advanced laboratorial practicum supported with complex software tools. As a rule an educational complex kit includes:
 - Course curriculum
 - Laboratory works curriculum
 - E-textbook
 - Program system for laboratory works support
 - Program system user's manual
 - Function library
 - Function library reference guide
 - PowerPoint presentation



Educational Complexes

(delivered, to be delivered shortly, just started)

- Computer algebra
- Parallel computing
- Modern methods of decision making
- Algorithms analysis and design
- Microprocessors architecture
- Databases
- Computational topology
- Numerical methods of linear algebra
- Models and methods of finitedimensional optimization
- Operating systems

- Probability theory and mathematical statistics
- Network technologies. Internet technologies
- Scientific programming using MATLAB
- Client-server applications
- Java 2 Micro Edition
- Microsoft .NET platform
- Introduction to the software engineering
- Zonnon programming language

Teaching Computer Science Conference (Zuzdal 2003, Pokrovskoe 2004)

Participants

- Leading IT Companies (Intel, IBM, Microsoft, HP, Motorola),
- Leading Russia software companies
- Leading Universities

Topics discussed

- Modern trends in IT
- Curricula development
- Information Technologies (new IT speciality)
- Universities and Companies needs
- Government support
- Future plans and forecasts







R&D projects

- Probabilistic Network Library (Intel Research 2003-2005)
- Machine learning (Intel Russia, 2002-2003)
- Fast Computing in Global Optimization: Sequential and Parallel Environment (Joint Russia –Dutch Project, 2004-2006)
- Build optimization process.
 Performance tuning with ClearCase (Telma, 2004)
- Optimizing MPI collective operations for Linux on Power processors. (IBM Research, 2005)
- .Net compiler (part of .Net processor project supported by Microsoft)
- Program optimization with MKL and IPP libraries (Intel)



PNL research project

Intel Research

University team – 3 professors, 8 students Principal Investigators – S. Belov, V.Gergel Started July 1, 2003 – prolonged

quarterly

- Objective to develop highperformance algorithms of inference and learning on probabilistic network.
- Open source library available on SourceForge
- Highly scalable ParPNL library for shared and distributed memory systems.
- Initiated by Intel. From 2004 ITLab team is the only team working on this project

PNL Library

Probabilistic Network Library

- Graph models making
- Models learning
- Incorporation of evidence
- Inference engine

ParPNL Project

- Learning of the theoretical foundations of the probabilistic algorithms
- PNL source code analysis and profiling
- Procedure parallelization for algorithms:
 - Junction Tree Gibbs sampling
 - Loopy-Belief EM Learning

Probabilistic Network

Graph model:



 A - man smokes
 Б - man has cancer of lung P(Б|А)=0.3

Project "Optimizing Performance of MPI open-source implementations for Linux on POWER processor clusters"

V. Grishagin, V. Gergel,S. Belov, A. Linev,A. Gergel, A. Grishagin,A. Kurylev, A. Senin



Faculty Awards for Innovation Program





Project goals

- Optimizing MPI algorithms for POWER clusters
- Tuning MPI performance for variety of cluster configurations
- Optimizing data transfer operations for POWER architecture

Lines of investigation

- Using compound algorithms with different schemas for local and network data transfers
- Taking into account current process locations (network node, processor)
- Effective using of shared memory in local transfers
- Considering specificity of POWER architecture

BCAST algorithm



POWER5 Architecture



HPC curriculum

The essential curriculum part is an integrated course "HPC and parallel programming" which provides

- studying the models of parallel computations,
- mastering in parallel numerical algorithms and
- getting practical experience in parallel programming.

The course provides good knowledge in many parallel programming areas (models, methods, technologies, programs) for students. Learning combines theoretical classes and laboratory works.



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Course "HPC and parallel programming": Educational Kit

- Course syllabus,
- Laboratory works syllabus,
- E-textbook,
- Program system for laboratory works support,
- Program system user's manual,
- Function library,
- Function library reference guide,
- PowerPoint presentations for all lections



4 чет (2,3)

1	№ и тип	Процессоры			
	итерации	1	2	3	4
	Исходные данные	2 3	38	56	14
	1 нечет	2 3	38	56	14
	(1,2),(3.4)	2 3	38	14	56
	2 чет	2 3	38	14	56
	(2,3)	2 3	13	4 8	56
	3 нечет	2 3	1 3	4 8	56
	(1,2),(3.4)				



Course "HPC and parallel programming": Syllabus

- Architecture of parallel computers and their classification,
- Models of computations and their analysis of complexity,
- Analysis of communication complexity of parallel programs,
- Technology for developing parallel programs,
 - Specialized parallel programming languages (OCCAM),
 - Parallel expansions for present-day algorithmic languages (OpenMP),
 - Developer's library for parallel programming (MPI),
- Parallel computation methods,
- Parallel computation models (Petri networks, "process-resource" models)
 Course is used in more 20 universities of Russia
 Development of updated version of the course
 has been supported by Microsoft
 Release date 2005, November

Course "HPC and parallel programming": Laboratory works syllabus

- Methods of parallel programs development for multiprocessor systems with shared and distributed memory using OpenMP and MPI technologies,
- Practicum on the development of parallel algorithms and programs for solving computational mathematics problems,
- Practicum on using parallel methods libraries for solving complex scientific and engineering problems



Course "HPC and parallel programming": Software Laboratory ParaLab

ParaLab provides

- Modelling of parallel systems,
- Choosing time-consuming problems and parallel methods for solving them,
- Making computational experiments (in simulation and real parallel modes),
- Visualizing computation processes,
- Accumulating and analyzing results ("experiment log")

System usage experience shows, that ParaLab may be useful for both novices, who are just starting to learn parallel computing, and experts in this perspective sphere of strategical computer technology

Course "HPC and parallel programming": Software Laboratory ParaLab Experiment's



Conferences

- International conference on computer graphic «Graphicon», MSU, Moscow, Russia
- International conference «Parallel Computing Technologies» (PACT), UNN, Nizhny Novgorod, Russia, 2003
- International Congress on Mathematical Modeling UNN, Nizhny Novgorod, Russia, 2004
- UK-RussianWorkshop on Proactive Computing, UNN, Nizhny Novgorod, Russia, 2005
- First All-Russian Winter School on Parallel Programming, UNN, Nizhny Novgorod, Russia, 2004
- All-Russian Seminar on High-Performance Parallel Computing, UNN, Nizhny Novgorod, Russia, 2003



Winter school on parallel computing 2004

- January 25 February 7, 2004
- 39 participants from 11 cities in CIS
- 6 lecture courses given by leading specialists in parallel computing
- scientific seminar







UK-Russia Workshop on Proactive Computing

February 3-6, 2005, UNN, Nizhny Novgorod, Russia Sponsored by British Council Organizers: Belov Sergey, Gergel Victor (UNN, ITLab) Robinson Peter (Cambridge University, Computer Lab) Participants from Moscow State University, St. Petersburg State University, University of Nizhny Novgorod, Cambridge University, University of Glasgow, leading software companies

Prof. Peter Robinson (Cambridge University) and Dr. Quentin Stafford-Fraser (Newham Research) and Ph.D student Maja Vukovic (Cambridge University) are studying proceedings

Proactive Computing







Comments,

Remarks...



Prepared by: V.Gergel, S.Belov, R.Mitin, O. Abrosimova. © ITLab, 2005