

TNO report
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Methods for Handling Ill conditioned data in the NIS. Intas 94-2204

Final report

1-10-95 to 1-4-98

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Netherlands Organization for Applied Scientific
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1 Research

1.1 Scientific Objectives

The principal goal of the project is to create and maintain a scientific and technical infrastructure for developing and adapting methods for handling ill-conditioned data. Ill-conditioned data refer to data that are, in principle, suitable for their intended purpose but are in some way distorted or incomplete. Statistical methods that are correct for distortions have been developed, but these are hardly available in the NIS countries. Applying such methods to problems in the NIS countries ultimately increases probability on well-informed policy decisions. Centers of expertise are needed to achieve this goal. The establishment of such a center in Moscow is the major aim of this project.

A specific sub-goal of the project is to utilize and foster talents of the FSU for solving ill-conditioned data problems. Competence in mathematics is high, but is also specialized towards particular areas. By concentrating on non-traditional subjects for which a clear need exists, it is expected that statistical expertise is directed towards issues that are relevant to the FSU. Also, FSU solutions to ill-conditioned data problems are of interest to the Western world.

1.2 Research Activities

1.2.1 Work carried out by each of the participants

Moscow:

- Participated in study trips to TNO Leiden with three participants
- Prepared two solicited proposals
- Prepared specifications for the CHILD site, and constructed and implemented the CHILD site
- Developed an algorithm and code for an imputation model based on logistic regression & linear regression
- Presented papers at conferences in Denver (USA), Voronezh, Tver, Cordoba, Paris and Sevastopol, Ukraine
- Co-authored two presentations at International conferences in Vienna and Barcelona
- Participated in co-ordination meetings and the project's workshop in Leiden and Tver.
- Prepared the co-editing of the monograph on the project.
- Developed and implemented an improved Gibbs sampler.
- Participated in the development of algebraic NIS approach

Almati:

- Participated in a study trip to Leiden
- Prepared a solicited proposal
- Participated in co-ordination meetings and the project's workshop in Leiden
- Participated in the algebraic NIS approach.
- Participated in the project's workshops in Leiden and Tver.

Kiev:

- Participated in a study trip to Leiden
- Prepared a solicited proposal
- Participated in co-ordination meetings and the project's workshops in Leiden and Tver
- Participated in the application and modelling on NIS laboratory data.

Leiden:

- Organized three study trips,
- Set up and chaired co-ordination meetings
- Organized and chaired a workshop on the solicited proposals,
- Organized a study course on multivariate analysis of missing data by multiple imputation.
- Prepared specifications for equipment and communications,
- Presented papers on international conferences in Vienna, Barcelona and Moscow
- Prepares the co-editing of the monograph on the project
- Co-ordinated various activities
- Present the round-up presentation of the project in Moscow.

1.2.2 Fit to the work program

The majority of the research has been according to the workprogram. The exception is the implementation of algebraic, combinatorial NIS approaches, however interesting, into the CHILD (Center Handling Ill Conditioned Data) in Moscow. The problem seems to be of a conceptual kind. The transformation from good ideas, like the combinatorial approach of Zhuravlov and Rudakov or the cluster analysis approach of Muchamedghaliev to workable solutions on public accessible platforms proved to hard to implement. The time and efforts needed for the conversion from (NIS) theory to practical applications was underestimated in the original proposal. Apparently such applications come more natural to the Western than to the NIS scientists. The transfer of Western technology and further dissemination into CHILD however went according to plan.

1.3 Scientific results

1.3.1 Main results and their significance

Main results are the introduction of the applied use of empirical bayes methods (including the Gibbs sampler) for handling missing data to the NIS statistical community. This is done by

letting the NIS participants do the actual building of the implementation and the actual conceptualizing involved. The area of application within applied statistics is missing data. This on itself is a relative new subject for the NIS statistical community. Tangible products are:

- More than 15 presentations on this new Western technology in Russian in Russia and Ukraine by NIS participants.
- The establishment of a working center for handling ill conditioned data (CHILD) in Moscow.
- A monograph on the project to be published in 1999.

1.3.2 Scientific papers and presentations

Proposals solicited from NIS counterparts resulted in the following papers, in English to be included in the monograph on the project's results: *Ill-conditioned data*, a monograph edited by V.V. Shakin and J.L.A. van Rijkevorsel to be published in English and Russian at the end of 1999.

- "*Modern Pattern Recognition Methods for Restoration of an ill-defined Matrix*", by Zhuravlov and Rhudakov (Moscow). submitted
- "*Ill-conditioned Data Generation Models for the Biosystems under Extreme Conditions*", by Shakin (Moscow). submitted
- "*Optimal control immune response, a dynamical model of the humoral immune system*", by Sergienko and Yanenko (Kiev). submitted
- *A missing data imputation technique based on cluster analysis*. by Muchamedgaliev (Almati). submitted
- "*Multiple imputation method for binary and polytomous data models. Implementing and testing*" by Citovtsev, Komissarov et al. (Moscow) submitted

Furthermore:

- *Ill conditioned Data generation Models and Regularisation Techniques*. V.V. Shakin. Abstracts of the 8-th International Conference on Pattern recognition, Moscow-Tver, 1997, pp. 123-124.
- *Possibilities of mathematical Modelling and Forecasting of Antropogenetic processes in: Ecology, Environmental Protection and Environmental Safety*. V.I. Danilov-Danilyan (ed.), International Independent University on Environmental and political Sciences, 1997, Moscow, Russia.
- *The INTAS project on ill conditioned data*. Y. Zhuravlov & V.V. Shakin. In: Abstracts of the 8th International Conference on Pattern Recognition. Moscow-Tver', 1997.- 236 pp.
- *Russian Federal and Regional Environmental Indices, Data Generation Models and Data processing routines*. V.V. Shakin submitted.
- *Centre for Handling Ill Conditioned Data (CHILD)*. Introduction and extensive description at homepage: <http://www.ccas.ru/~cito/CHILD/main.htm>
- *Sustainable development and the quality of life: Definition and Models*. V.V. Shakin et al. In: Abstracts of the International Conference: Ecology, Ecological Education and Non-linearity. September 22-27, 1997 Voronezh, Russia, pp. 195-197.

Presentations

- *On applications in Russia in particular.* V.V. Shakin. Presented at the SETAC meeting of EPA (Environmental Protection Agency), Denver, CO, USA, April 1996.
- *On the quality of public-use data in central and eastern Europe.* J.L.A. van Rijckevorsel et al.. presented at the 4th World Congress of the Bernoulli Society, Vienna, August 1996.
- *On the practice of handling ill-conditioned data in central and eastern European countries* J.L.A. van Rijckevorsel et al. Presented at the 6th International Conference on System Science in Health Care in Barcelona, September 1996.
- *On the relevance of handling ill-conditioned data in Russia and the Ukraine* V.V. Shakin et al. Presented at the 2nd Practical Conference on Sustainable Development: System Analysis in Ecology, Sevastopol, September 1996, Ukraine.
- *Sustainable criteria for living systems.* V.V. Shakin. Seminar University of Cordoba, Spain, February 1997.
- *Child and Mice, the round-up of an international co-operation on ill conditioned data.* INTAS 94-2204. J.L.A. van Rijckevorsel. Invited plenary lecture at the International Session of the 30th Seminar on Multivariate Statistical Analysis and Probabilistic Modelling of Real Processes. Moscow June 1999.

Scientific Output	Published	In press/accepted	Submitted	In preparation
International			5	
National				
Abstract	14			
Monograph		1		
Internal				
Thesis				
Patent				
Presentation	16			

1.4 Applications

Applications

- An algorithm and code for an imputation model based on binary and polytomous logistic regression made by the NIS participants is implemented in the TNO missing data machine.
- The CHILD missing data machine is conceptualized, specified and build by NIS participants in Moscow
- The methods for handling ill conditioned data were used to treat clinical and immunological laboratory data from patients exposed to radioactive radiation in Ukraine.
- The newly developed Gibbs sampler was successfully tested on FSU data and on data from the Netherlands.
- Ill-conditioned data generation techniques were developed for various applications in ecology and medicine.

2 Management

2.1 Meetings and visits

In co-ordination meetings in Leiden and Moscow goals, objectives and activities were discussed and further implementation was detailed.

Leiden, Project Co-ordination Meeting 5 July 1996. Participants: Shakin, Citovtsev, Komissarov, Yaneko, Muchamedgalief, van Rijckevorsel

Leiden, Project Co-ordination Meeting 18 July 1996. Participants: Shakin, Citovtsev, Komissarov, van Rijckevorsel

Moscow, Project Co-ordination Meeting May 1997. Participants: Shakin, Zhuravlov, Rhudakin, van Rijckevorsel

Moscow, Project Co-ordination Meeting March 1998. Participants: Shakin, Citovtsev, Komissarov, van Rijckevorsel

Moscow, Project Co-ordination Meeting, March 1999 Participants: Shakin, Citovtsev, Komissarov, van Rijckevorsel

INTAS workshop on ill conditioned data in Leiden, July 5th 1996. The solicited NIS proposals prepared in writing funded by the advanced payment of INTAS were presented by the NIS participants in a workshop in Leiden on 5th July 1996. The dissemination was further detailed by preparing the outline of a common bilingual volume to be published by CCAS publishers in Moscow.

Study trips in 1996 The Western technology of handling faulty data is introduced using the study trips by three NIS participants and the twinning of two NIS junior scientists for three months at TNO PG in Leiden, The Netherlands. In order to get familiar with the TNO missing data approach they developed an algorithm and code for the logistic regression imputation model to be used in Moscow and Leiden.

The FSU Workshop on the project was prepared in a series of ordination meetings. The workshop was arranged in frame of the 8th NIS/FSU Conference on Mathematical Methods for Pattern Recognition and Optimisation (MMPO-8) held in city of Tver', Russia, October 27- 31, 1997.

Visits	# of scientists	# person days
West ->East	1	15
East -> West	5	134
West -. West	0	0
East -. East	5	25

2.2 Collaboration

<i>Intensity of collaborations</i>	High	Rather high	Rather low	Low
West -> East		X		
East -> West			X	
West -. West				X
East -. East		X		

2.3 Time schedule

The time planning has not totally been accordance with the work program. There were delays in the transfer of funds and with the purchase of equipment because of internal disagreements among the NIS participants. Result is that the last step of the rounding up phase is to take place in June 1999.

According to the planning diagram in the work program paragraph 4.2:

1. Set-up phase: completed.
2. Set-up phase: completed. The subscription to JASA is not accomplished because of internal complications at the NIS participants.
3. Set-up phase: completed.
4. Twinning phase: all studytrips are completed in time.
5. Twinning phase: see website: completed.
6. Dissemination phase: completed. NIS methodology is not implemented.
7. Dissemination phase: see website: completed.
8. Application phase: applied analyses are completed.
9. Application phase: delayed: Applied papers to be included in the Monograph to be published at the end of 1999.
10. Round-up phase dissemination within NIS: completed.
11. Round-up phase: delayed: Monograph to be published at the end of 1999.

2.4 Problems encountered

Transfer of funds, purchase of equipment. It was agreed that one participant, Prof. Zhuravlov, would receive and distribute the funds for all NIS partners. This was apparently not acceptable anymore for the NIS partners around the payment of the second tranche in March 1998. For a period of more than one year it was unclear how and to whom the remaining funds had to be sent. After the deadline of the project's duration there was still no solution what to do with the

funds. For this reason the final report to INTAS and the purchase of equipment was accordingly delayed. The co-ordinator proposed to return the remaining funds to INTAS. Only then (1999) some form of agreement among NIS participants was reached that the co-ordinator will pay the supplier of equipment (13000 ECU) directly and the remaining fees will be sent to Prof. Zhuravlov by banktransfer who will then distribute the fees over the participants.

- 2. Set-up phase: The subscription to JASA is not accomplished because there was no acceptable recipient in Moscow
- 5. Twinning phase: See above. There was a delay because of transfer of funds. Completed 1999.
- 6. Dissemination phase: NIS methodology is not implemented because analytical problems.
- 10. Round-up phase: Completed and the round up presentation is to be held in June 1999 in Moscow.
- 11. Round up phase: The publication of the monograph is delayed and will take place end of 1999.

<i>Problems encountered</i>	Major	minor	None	Not applicable
Co-operation of team members	X			
Transfer of funds	X			
Telecommunication		X		
Transfer of goods				X

2.5 Actions required

None.

2.6 Manpower invested

The estimated amount of manpower equals 180 manmonths from the NIS participants and 5 months from the Western participant.

3 Finances

3.1 Money spent by participant

Participant		Cost category						TOTAL
#	Name of Participant	Individual Grants labor Costs	Overheads	Travel and subsistence	Equipment	Consum- ables	Other Costs	
1	TNO Leiden		17500				500	18000
2	Glushkov Kiev	5450	500	1500	500			7950
3	CC RAS Moscow	21000	1000	14139	11000			47139
4	DIZON Almati	4400	500	1500	500			6900
TOTAL		30850	19500	17139	12000		500	79989

3.2 Spending in accordance with the workprogram?

The spending is in accordance with the work program. 3000 ECU were spent on labor in stead of travel by the NIS participants.

3.3 Other funding

The majority of the costs of the co-ordinator's travel to and subsistence in Moscow were funded by TA projects in Russia funded by Tacis/WB.

Some of the activities of the NIS participants were co-funded by the Swiss national Science Foundation (SNSF).

4 Summary of Results and Key References

TITLE

Title: Methods for handling ill-conditioned data in the FSU
No.: INTAS-94-2204
Start: 1 October, 1995 with a duration of 30 months
Project co-ordinator: Dr. J.L.A. van Rijckevorsel, TNO-PG, Leiden
Period: Report relates to the period from 1 October 1995 until 1 April 1998
Address co-ordinator: TNO Prevention and Health
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RESULTS

The main activities were a write up of the respective ideas and models for handling missing data of the NIS members, learning the western MI methods and their implementation by NIS participants. First results and initiatives were made public in on four international scientific conferences in the Russia, Slovak Republic, USA, Austria, Spain and the Ukraine. The next activities were the follow-up of the workshop in Leiden on 5 July 1996 and of the study trips by three NIS participants and the twinning of two NIS junior scientists for three months at TNO PG in Leiden, The Netherlands. The simulation of the TNO missing data machine (MICE) on Russian grounds through CHILD was the main achievement. A NIS proposal to generate the problem-oriented metrics for genetic sequences, with possible application for algebraic methods in data conditioning was developed. Main results of the activities are the introduction of the applied use of empirical Bayes methods (including the Gibbs sampler) for handling missing data to the NIS statistical community. This is done by letting the NIS participants do the actual building of the implementation and the actual conceptualizing involved. The area of application within applied statistics is missing data. This on itself is a relative new subject for the NIS statistical community. Tangible products are:

- 15 Presentations on this new Western technology in Russian in Russia and Ukraine by NIS participants.
- The establishment of a working center for handling Ill conditioned data (CHILD) in Moscow.
- A monograph in English on the subject to be published in 1999 by CCAS publishers Moscow.

These research activities have been carried out in accordance with those indicated in the work program of the INTAS co-operation agreement.

KEY REFERENCES

The main source about the project's results is the homepage made by the NIS participants:

<http://www.ccas.ru/~cito/CHILD/main.htm>.

Furthermore the following papers, in English are included in the monograph on the project's results: *Ill-conditioned data*, monograph edited by V.V. Shakin and J.L.A. van Rijkevorsel to be published in English and Russian at the end of 1999:

- “*Modern Pattern Recognition Methods for Restoration of an ill-defined Matrix*”, by Zhuravlov and Rhudakov (Moscow). submitted
- “*Ill-conditioned Data Generation Models for the Biosystems under Extreme Conditions*”. by Shakin (Moscow). submitted
- “*Optimal control immune response, a dynamical model of the humoral immune system*”, by Sergienko and Yanenko (Kiev). submitted
- *A missing data imputation technique based on cluster analysis*. by Muchamedgaliev (Almati). submitted
- “*Multiple imputation method for binary and polytomous data models. Implementing and testing*” by Citovtsev, Komissarov et al. Submitted.

5 Role and Impact of INTAS

<i>Role of INTAS</i>	Definitely yes	Rather yes	Rather not	Definitely not
Would the project have been started without funding by INTAS?		X		
Would the project have been carried out without funding from INTAS?			X	

<i>Main achievement of the project</i>	Very important	Quite important	Less important	Not important
Exciting science		X		
New international contacts			X	
Additional prestige for my lab		X		
Additional funds for my lab				X
Helping scientists in the NIS	X			
Other: creating synergy between this project and TA projects (Takis, WB) my lab is involved in.				

6 Recommendations to INTAS

To be kept:

- The studytrips were very successful and efficient. In particular those of the junior scientists that lasted several months.
- Local conferences in the NIS countries.
- Adaptation of western technology by NIS participants.
- Improving living conditions of NIS scientists, even temporary.

To be left out:

- Short studytrips of senior scientists.
- Purchase of equipment (an INTAS office in Moscow would have been most welcome).
- The actual transfer of money by the co-ordinator.

Appendix A Individual Contributions

K.L. Atoev (Moscow)

- Preparation of a solicited proposal.
- Applied the methods for handling ill-conditioned data were to treat the clinical and immunological laboratory data for the patients exposed to radioactive radiation.
- Contributed to the project's workshop.

V.E. Csitovtsev (Moscow)

- The development of algorithm and code for an imputation model based on logistic regression.
- The preparation and presentation of a paper on an imputation model based on logistic regression.
- A Visit of three months at the Department of Statistics TNO PG Leiden.
- The Co-operation with the Department of Medical Statistics Erasmus University in Leiden.
- Participated in co-ordination meetings and the project's workshop.
- Developed an improved version of the Gibbs sampler based on two methods of multiple imputations (linear regression and polytomous regression). Written code in C for Win32 platform.
- Contributed to the project's workshop in Tver.

K.V. Komissarov (Moscow)

- The development of algorithm and code for an imputation model based on logistic regression.
- The preparation and presentation of a paper on an imputation model based on logistic regression.
- A Visit of three months at the Department of Statistics TNO PG Leiden.
- Co-operation with the Department of Medical Statistics Erasmus University in Leiden.
- Participated in co-ordination meetings and the project's workshop in Leiden.
- Tested successfully the Gibbs sampler on Russian data and on the data received from TNO Leiden.
- Contributed to the project's workshop in Tver.

A.F. Muchamedgaliev (Almati)

- Participated in co-ordination meetings and the project's workshop in Leiden.
- Preparation & presentation of a solicited proposal.
- Study visit to at the Department of Statistics TNO PG Leiden of one week.
- Applied methods of optimization to improve algorithms of taxonomy used for filling the gaps in the missing data. The algorithm was implemented for Win32 platform using DELPHI.
- Participated as a contributor and a chairperson in the project's workshop in Tver.

J.L.A. van Rijckevorsel (Leiden)

- Presentations in Vienna and Barcelona.
- Edits the proceedings together with Shakin.
- Organized all study visits at the Department of Statistics TNO-PG.
- Project co-ordination.

K.V. Rhudakov (Moscow)

- Preparation of a solicited proposal.
- Developed an approach to generate the problem-oriented metrics for genetic sequences, with possible application of it for algebraic methods in data conditioning.
- Organized the project's workshop in Tver.

V.V. Shakin (Moscow)

- Preparation & presentation of a solicited proposal.
- Study visit to at the Department of Statistics TNO PG Leiden of one month.
- Co-ordinates the implementation of the CHILD site.
- Participated in co-ordination meetings and the project's workshop in Leiden.
- Developed ill-conditioned data generation models for various applications in ecology and medicine, and regularization techniques for conditioning the related data.
- Participated in the project's workshop in Tver.
- Presentation in Denver, Cordoba and Voronezh.
- Edits the proceedings together with Van Rijckevorsel.

I.V. Sergienko (Kiev)

- Preparation of a solicited proposal.
- Contributed to the project's workshop in Tver.

V.M. Yanenko (Kiev)

- Participated in co-ordination meetings and the project's workshop in Leiden.
- Preparation & presentation of a solicited proposal.
- Study visit to at the Department of Statistics TNO PG Leiden of one week.
- Collected data for the patients exposed to radioactive radiation. The data were treated using the methods for handling ill-conditioned.
- Contributed to the project's workshop in Tver.

Yu.I. Zhuravlov (Moscow)

- Preparation of a solicited proposal.
- Scientific co-ordination at the NIS side.
- Acted as a President of the project's workshop in Tver.

Appendix B List of Equipment procured

Item No.	Description of item	Unit Price	Qty
1	Computer Pentium-2/450*2/Dual Processor/256MB RAM PCI Wide SCSI/ HDD 18,2Gb SCSI-2 /3D 16MB / Adaptec AHA 2940/3.5"/cdrom32x/SB32/ EtherFast10/100 PCI card 15" monitor Sony CPD 100 ^{ES} , NT server OS		
2	Computer Pentium-2/400/Endeavour/128MB/ SCSI adapter BL950/ HDD 12Gb SCSI-2 Quantum/3.5"/2000 Jazz drive Iomega/ EtherFast 10/100 PSI card/ 17" monitor Sony CPD 200pst/WIN 95	\$2 631	1
3	Notebook Navigator AT6 IMM P2-366/96/6400/dvd/	\$3 495	1
4	Compex 100 Mbit,8-TP/1-BNC RX 1208	\$167	1
5	Compex FI 100 TX	\$50	1
6	Printer HP LJ 2100	\$750	1
7	Cdrom Recordable Yamaha 4416S 4/4/16 wh disks	\$501	1
8	Copier Canon NP 6216	\$1 155	1
9	Fax Panasonic KX-F780BX	\$270	3
10	Scanner Umax Astra 1220U (USB)	\$198	1
11	Cartridge for Jazz drive	\$81	3
12	Paper	\$4	20
13	Thermal paper for fax	\$3	10
14	Diskettes	\$0,80	100

Appendix C List of Books procured and distributed

Three copies of each title:

Bayesian Data Analysis:

B.P. Carlin, T.A. Louis (1996), *Bayes and Empirical Bayes Methods for Data Analysis*, Chapman Hall, London.

A. Gelman, J.B. Carlin, H.S. Stern, D.B. Rubin (1995), *Bayesian data Analysis*, Chapman Hall, London.

Imputing Missing Data:

R.J.A. Little, D.B. Rubin (1987), *Statistical Analysis with Missing Data*, Wiley, New York.

D.B. Rubin (1987), *Multiple Imputation for Nonresponse in Surveys*, Wiley, New York.

Computer intensive methods for Bayesian analysis

M.A. Tanner (1996), *Tools for Statistical Inference*, Springer, New York.

W.R. Gilks, S. Richardson, S.J. Spiegelhalter (1996), *Markov Chain Monte carlo in Practice*, Chapman Hall, London.

W.H. Press, S.A. Teukolsky, W.T. Vetterling, B.P. Flannery (1996), *Numerical Recipes in C*, Cambridge University Press, Cambridge, UK.

Non-linear models

P.McCullagh, J.A. Nelder (1996), *Generalized Linear Models*, Chapman Hall, London.

