



# Curriculum Vitae and Research Statement

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## 1. Research profile

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| Recent topics:        | <ul style="list-style-type: none"><li>○ integrating Bioinformatics resources with Semantic Web Services</li><li>○ semantic technologies for Clinical Intelligence</li><li>○ scalable semantic querying of relational DB</li><li>○ practical commonsense reasoning and NLP-oriented knowledge engineering (industrial R&amp;D)</li><li>○ efficient implementation techniques for automated reasoning</li></ul>   |
| Publications:         | 7 journal articles and book chapters, 14 conference papers  |
| Programme committees: | 6 international workshops   |
| Software:             | <ul style="list-style-type: none"><li>○ world-leading theorem prover Vampire</li><li>○ commonsense reasoning, semantic analysis and knowledge aquisition components of an NLP toolkit (industrial work)</li><li>○ unprecedentedly expressive semantic querying and integration of RDB (experimental system)</li><li>○ Semantic Web services for various bioinformantics resources</li><li>○ SPARQL query engine for SADI Semantic Web Services (work in progress)</li></ul> |

I have a strong interest in the Semantic Web-oriented reasoning technologies and semantic technologies in general. In particular, my current work in the University of New Brunswick and IPSNP Computing Inc is dedicated to the use of Semantic Web Services for publishing

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<sup>1</sup>In my current passport my name is spelled as “Alexander Ryazanov”, whereas in the previous passport it was “Alexandre Riazanov”.

bioinformatics resources. More specifically, I and my colleagues are conducting large case studies to develop transferable methodologies for the application of the SADI Semantic Web Services framework for bioinformatics tasks requiring agile integration of multiple distributed bioinformatics databases and algorithmic resources. The case studies we are working on are (i) *mutation impact extraction* from texts and semantic indexing based on the text-mining results, (ii) ontology-based *lipid classification*, integrated with related bioinformatics data, (iii) integration of *fish toxicology* data with related bioinformatics resources and (iv) *semantic access to a hospital database* for surveillance of hospital-acquired infections. Also, as a CTO of IPSNP Computing Inc which I co-founded with Dr. Chris Baker to commercialise this research, I am developing an industrial-strength SPARQL engine for SADI services, which is a research-intensive task.

I am also doing both experimental and theoretical research on *query answering over large relational databases and RDF stores modulo expressive knowledge bases*, such as OWL ontologies and rule bases, using adapted classical reasoning techniques<sup>2</sup>. This research is advancing the state of the art in Web-scale *semantic search*, which is envisioned as one of the cornerstone technological components of the Semantic Web, and corporate-scale *semantic access to databases* and integration of relational databases with Web Services, spreadmarts and XML repositories.

I am exploring possibilities of applying this technology (i) to enable more efficient processing of medical and biological research data<sup>3</sup> and (ii) to integrate distributed and heterogeneous data and enable non-technical user access to the data, for business intelligence and e-marketing. This has led to an experimental implementation allowing to query large conventional relational databases modulo arbitrary knowledge bases expressed in first-order logic. The prototype allows cross-querying several databases with the help of third-party data federation platforms. It can also be used for querying RDF repositories via RDBMS-based back-ends of third-party triplestores stores, such as Sesame. There is also a front-end that allows to query *arbitrary SPARQL endpoints* by rewriting expressive SPARQL queries into directly executable SPARQL queries.

As part of my work at North Side Inc., I was developing practical methods for commonsense reasoning in natural language processing (NLP) applications, more specifically - natural language understanding (NLU). This work includes research and creative engineering in (i) *semantic modelling of the English language*, (ii) *knowledge representation and acquisition*, (iii) *practical methods of reasoning with large expressive ontologies and rule sets*, (iv) NLU-oriented *nonmonotonic, temporal and taxonomic reasoning*.

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<sup>2</sup>This work started when I was in Manchester – in our ISWC 2004 paper (see the publication list below) we describe experiments with Vampire on a biochemistry and medical terminology ontology.

<sup>3</sup>This is one of the most promising applications, at least in the short run. Note also that in the literature a very large proportion of experiments with semantic querying is concerned with the use of biomedical knowledge bases, such as Gene Ontology, BioPAX, UniProt, SNOMED CT and UMLS. My current work will give a new edge to this area due to its emphasis on higher expressiveness, in particular by enabling the use of rule-based knowledge bases.

Since 1998 I have been doing research in efficient implementation techniques for automatic reasoning, which is one of my main areas of expertise. My research contributions to the area include novel *methods of organising proof-search*, which dramatically improves its effectiveness, state-of-the-art *indexing techniques* for the key data retrieval-based operations underlying proof search, and efficient solutions to other core algorithmic problems, such as handling *term ordering constraints*.



In the past I developed a high-performance resolution- and paramodulation-based prover, in collaboration with Prof. Andrei Voronkov, to support our research in implementation techniques. The system is used as the kernel of the *theorem prover Vampire*, which has been the first place winner in the main divisions of the world cup for theorem provers (CASC) for many years. A new theorem prover for temporal logic, TeMP, implemented in Liverpool, is also built around the Vampire kernel.

Vampire has been used in a number of research projects in leading universities and research institutions (e. g., Manchester University, Cambridge University, MIT, University of Toronto, NASA Ames Research Center), and industrially.

I have published 6 refereed journal articles, 1 book chapter, 14 peer-reviewed conference papers (the three most cited publications have Google Scholar citation index 329, 105 and 72), and numerous technical reports and abstracts. I have given presentations at a number of prestigious international events, including an invited talk at one of the main workshops in the area of automated reasoning. I have worked in programme committees of 6 major workshops on automated reasoning and semantic technologies. I have reviewed several dozens of international conference papers and journal articles on various subjects in Artificial Intelligence and Bioinformatics.

## 2. Employment and study

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|--------------|--|------------------------|
| 2011-to date | IPSNP Computing Inc, Canada                              | co-founder & CTO       |
| 2010-to date | University of New Brunswick, Canada                      | Sr. Research Scientist |
| 2005-2010    | North Side Inc, Montreal, Canada                         | R&D Engineer           |
| 2002-2005    | Manchester University, Comp. Sci. Dept.                  | Research Associate     |
| 1999-2002    | Manchester University, Comp. Sci. Dept.                  | PhD student            |
| 1998-1999    | Uppsala University, Comp. Sci. Dept.                     | Visiting Researcher    |
| 1995-1998    | Ershov's Inst. of Informatics Systems                    | PhD stud. (unfinished) |
| 1992-1995    | Shadrinsk State Pedagogical Inst., Phys. and Math. Dept. | TA, Lecturer           |
| 1988-1992    | Novosibirsk State Uni., Mech. and Math. Dept.            | undegr. student        |

In August 2011 I and Dr. Chris Baker founded IPSNP Computing Inc – a startup dedicated to commercialising some prior research on Bioinformatics data integration and Clinical Intelligence with SADI Semantic Web Services. As the CTO, I am doing the background research and developing an initial prototype for IPSNP’s main product – the Hydra SPARQL engine for SADI services.

Since July 2010 I have been working in Dr. Chris Baker’s group in the University of New Brunswick, Saint John, as a Senior Research Computer Scientist. I am conducting large coherent case studies to explore the value of Semantic Web services, in particular SADI framework, for the purposes of agile integration of distributed, heterogeneous and autonomous bioinformatics resources. Our goal is to develop transferable methodologies for such integration in practical settings, and to identify directions for further development of Semantic Web services and related infrastructure. For example, we have conducted a case study in which information about *mutations* mined from scientific publications is used in combination with several external bioinformatics databases and programs, to facilitate several biological research-motivated use scenarios. In another case study, we use SADI services in a Clinical Intelligence scenario to implement ad hoc querying of a hospital DB for the purposes of hospital-acquired infections surveillance.

Apart from the research dimension, this work allows me to practically exercise a diverse set of technical skills ranging from advanced Knowledge Engineering to Web programming, and to gain hands-on experience with a large set of bioinformatics databases, programs and knowledge bases. My duties also include supervision of more junior team members and teaching at training courses for SADI Semantic Web services.

In 2005-2010 I worked as an R&D Engineer for North Side Inc., based in Montreal, Canada. The company is developing a technology for deep semantic analysis of English texts and support of interactive dialogues, and applying it to on-line game development. My main role in the project is the development and implementation of efficient *practical methods of commonsense reasoning* as applied to *natural language understanding*. In the course of this work I have conducted a number of research projects on semantic modelling of natural languages, related reasoning support, knowledge acquisition from lexical resources and logic-based knowledge representation formalisms suitable for semantic modelling of the English language. I implemented a number of experimental semantic analysis and reasoning systems in Java and C++. My day-to-day duties also included training new team members.

In 2002-2005 I was working as a *Research Associate* at the *School of Computer Science, The University of Manchester*, within an EPSRC funded project “Development of a Next Generation Theorem Prover” led by Prof. Andrei Voronkov. The project was aimed at extending the range of applications of automatic theorem provers. My work within the project was focused on *extending the functionality and improving the performance* of the theorem prover Vampire [http://en.wikipedia.org/wiki/Vampire\\_\(theorem\\_prover\)](http://en.wikipedia.org/wiki/Vampire_(theorem_prover)), based on *state-of-the-art theory and novel implementation techniques*. This work strengthened the position of Vampire as a world-leading prover. I also did several smaller projects jointly with colleagues from the UK and Europe, including (i) the creation of the testing and benchmarking framework

COMPIT for term indexing, (ii) the implementation of the temporal theorem prover TeMP, based on the Vampire kernel, and (iii) a case study on using Vampire for reasoning with OWL ontologies (two biomedical ontologies were used) and SWRL.

In 1999-2002 I was a *PhD student* at the *Computer Science Department* of *The University of Manchester* under the supervision of Prof. Andrei Voronkov. For my PhD project I was doing research in *efficient implementation techniques for resolution- and paramodulation-based automated theorem proving* ([http://www.freewebs.com/riazanov/Riazanov\\_PhD\\_thesis.pdf](http://www.freewebs.com/riazanov/Riazanov_PhD_thesis.pdf)). I was developing the Vampire kernel as the main experimental vehicle for this research.

In 1998-1999 I was working as a *visiting researcher* in the *Computer Science Department, Uppsala University*, where I started my work on Vampire by reimplementing the original prototype written by Andrei Voronkov into a fully functional system. This implementation proved very competitive as it won the main division in CASC – the world cup for theorem provers – in 1999, after only one year of development.

In 1995-1998 I was working on the design and implementation of a concurrent logic programming language intended for integration of heterogeneous deductive components. This work was done as a part of a PhD course at the *Ershov's Institute of Informatics Systems, Novosibirsk*, which I left because of the opportunity to work on Vampire.

In 1992-1995 I was teaching programming and numerical analysis at the Department of Physics and Mathematics of the *Shadrinsk State Pedagogical Institute* (Shadrinsk, Russia), first as an assistant and later as a lecturer.

Since 1988 I studied applied mathematics at the *Novosibirsk State University*, Russia, with specialisation in Computer Science, and in 1992 graduated with a degree equivalent to the British MSc.

## 4. Teaching experience

In 1993-1995 I did a lot of teaching (up to 18 hours of class work per week, all year round) for undergraduate Mathematics, Physics and Informatics students in a small university in my home town (Shadrinsk State Pedagogical Institute). The class work included lectures, tutorials and lab demonstration for programming courses at all levels and a basic numerical analysis course. I also supervised the course and diploma work of several students and mentored a group of programming enthusiasts on a voluntary basis. In Manchester University, I did lab demonstrations. As part of my recent industrial work, I provided training to other team members on various Knowledge Engineering and Automated Reasoning-related subjects. My current work involves the preparation and teaching of modules for SADI Semantic Web service training courses for academic and industrial audiences.

## 5. Software development experience

I have been developing software for 24 years in many languages, on many platforms, including various flavours of Unix, Linux and MS Windows, using many different technologies. In particular, I have extensive experience in programming large systems with extreme efficiency requirements, very complex data flow, sophisticated data structures and nontrivial memory management in C++ (Vampire is fully implemented in this language). Recently I have been programming a lot in Java. In the past I did a lot of programming in Lisp and Standard/Concurrent ML. I occasionally program in C and Prolog. Since my current interests require experimental work in the areas of databases and semantic technologies, I have a working knowledge of the key DB technologies (RDBMS, SQL, JDBC, OODBMS, relevant parts of J2EE) and W3C standards (XML, RDF, OWL, SWRL, RIF).

## 6. Selected publications<sup>4</sup>

The list includes neither small abstracts, nor technical reports fully superseded by conference or journal publications.

### PhD thesis

- A. Riazanov, Implementing an Efficient Theorem Prover, PhD thesis, The University of Manchester, 2003, available as [http://www.freewebs.com/riazanov/Riazanov\\_PhD\\_thesis.pdf](http://www.freewebs.com/riazanov/Riazanov_PhD_thesis.pdf)

### Refereed journal articles and book chapters

- A. Riazanov and A. Voronkov, The Design and Implementation of Vampire, *AI Communications*, 15:2-3, 2002.
- A. Riazanov and A. Voronkov, Limited Resource Strategy in Resolution Theorem Proving, *Journal of Symbolic Computation*, 36:1-2, 2003.
- A. Riazanov and A. Voronkov, Efficient Instance Retrieval with Standard and Relational Path Indexing, *Information and Computation*, 199:1-2, 2005.
- A. Riazanov and M. A. T. Aragão, Incremental Query Rewriting with Resolution, in *Canadian Semantic Web II*, 2010.
- J. B. Laurila, N. Naderi, R. Witte, A. Riazanov, A. Kouznetsov and C. J. O. Baker, Algorithms and Semantic Infrastructure for Mutation Impact Extraction and Grounding, *BMC Genomics*, 11(Suppl 4):S24, 2010.

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<sup>4</sup>See also <http://www.freewebs.com/riazanov/publications.htm>.

- A. Riazanov, J. B. Laurila and C. J. O. Baker, Deploying Mutation Impact Text-Mining Software with the SADI Semantic Web Services Framework, *BMC Bioinformatics* 2011, 12 (Suppl 4):S6, 2011.
- L. L. Chepelev, A. Riazanov, A. Kouznetsov, H. S. Low, M. Dumontier, C. J. O. Baker, Prototype Semantic Infrastructure for Automated Small Molecule Classification and Annotation in Lipidomics, *BMC Bioinformatics* 2011, 12(1):303, 2011.

### Refereed conference papers

- A. Riazanov and A. Voronkov, Vampire, *Proc. CADE-16*, LNAI 1632, 1999.
- A. Riazanov and A. Voronkov, Partially Adaptive Code Trees, *Proc. JELIA*, LNAI 1919, 2000.
- A. Riazanov and A. Voronkov, Vampire 1.1 (System Description), *Proc. IJCAR-1*, LNAI 2083, 2001.
- R. Nieuwenhuis, T. Hillenbrand, A. Riazanov and A. Voronkov, On the Evaluation of Indexing Techniques for Theorem Proving, *Proc. IJCAR-1*, LNAI 2083, 2001.
- A. Riazanov and A. Voronkov, Splitting without Backtracking, *Proc. IJCAI-17*, vol. 1, 2001.
- A. Riazanov and A. Voronkov, Adaptive Saturation-Based Reasoning, *Proc. PSI 2001*, LNCS 2244, 2001.
- A. Riazanov and A. Voronkov, Efficient Instance Retrieval with Standard and Relational Path Indexing, *Proc. CADE-19*, LNAI 2741, 2003.
- A. Riazanov and A. Voronkov, Efficient Checking of Term Ordering Constraints, *Proc. IJCAR 2004*, LNAI 3097, 2004.
- U. Hustadt and B. Konev and A. Riazanov and A. Voronkov, **TeMP**: A Temporal Monodic Prover, *Proc. IJCAR 2004*, LNAI 3097, 2004.
- D. Tsarkov and A. Riazanov and S. Bechhofer and I. Horrocks, Using Vampire to Reason with OWL, *Proc. ISWC 2004*, 2004.
- A. Riazanov, Efficient Semantic Querying of Relational Databases with Resolution, *Proc. CSWWS 2009*, 2009.
- A. Shaban-Nejad, G. W. Rose, A. Okhmatovskaia, A. Riazanov, C. J. Baker, R. Tamblin, A. J. Forster, D. L. Buckeridge, Knowledge-based Surveillance for Preventing Postoperative Surgical Site Infection, *Proc. MIE* 2011.
- M. M. Hindle, A. Riazanov, E. S. Goudreau, C. J. Martyniuk, C. J. O. Baker, Leveraging SADI Semantic Web Services to Exploit Fish Toxicology Data, *Proc. CSWWS 2011*, 2011.
- A. Riazanov, A. Shaban-Nejad, A. Klein, G. W. Rose, A. J. Forster, D. L. Buckeridge, C. J. O. Baker, Towards Clinical Intelligence with SADI Semantic Web Services: a

Case Study with Hospital-Acquired Infections Data, SWAT4LS 2011, 2011.

### Electronically published (not refereed or lightly refereed)

- A. Riazanov, New Implementation Framework for Saturation-Based Reasoning, ArXiv preprint arXiv:0802.2127, available from <http://arxiv.org/>, 2006.
- A. Riazanov, Resolution-based Query Answering for Semantic Access to Relational Databases: A Research Note, ArXiv preprint arXiv:0901.0339, available from <http://arxiv.org/>, 2009.
- A. Riazanov, J. B. Laurila and C. J. O. Baker, Deploying the Mutation Impact Mining Pipeline with SADI: an Exploratory Case Study, Proc. AIMM 2010, 2010.

## 7. Conference presentations and tutorials

- System Description: Vampire 1.0, *Seventh Workshop on Automated Reasoning (ARW 2000)*, 2000.
- Partially Adaptive Code Trees, *European Workshop on Logics in Artificial Intelligence (JELIA 2000)*, 2000.
- Vampire 1.1 (System Description), *First International Joint Conference on Automated Reasoning (IJCAR-1)*, 2001.
- Making Your Prover Meet the Deadline, *Eighth Workshop on Automated Reasoning (ARW 2001)*, 2001.
- Splitting without Backtracking, *Seventeenth International Joint Conference on Artificial Intelligence (IJCAI 17)*, 2001.
- Adaptive Saturation-Based Reasoning, *Perspectives of System Informatics, 4th International Andrei Ershov Memorial Conference (PSI 2001)*, 2001.
- Path-indexing with database joins for efficient retrieval of instances and backward subsumption, *Deduction, Schloss Dagstuhl seminar no. 01101*, 2001, jointly with A. Voronkov.
- Splitting without backtracking, *Semantic Foundations of Proof-search, Schloss Dagstuhl seminar no. 01141*, 2001.
- Invited talk: Towards efficient backward demodulation, *3rd International Workshop on the Implementation of Logics (associated with LPAR)*, 2002.
- Efficient Instance Retrieval with Standard and Relational Path Indexing, *19th International Conference on Automated Deduction (CADE-19)*, 2003.
- Efficient Checking of Term Ordering Constraints, *Second International Joint Conference on Automated Reasoning (IJCAR 2004)*, 2004.

- Efficient Semantic Querying of Relational Databases with Resolution, *The Second Canadian Semantic Web Working Symposium (CSWWS 2009)*, 2009.
- Algorithms and Semantic Infrastructure for Mutation Impact Extraction and Grounding, *The 9th International Conference on Bioinformatics (InCoB 2010)*, 2010.
- Expressive Querying of Semantic Databases with Incremental Query Rewriting, *Atlantic Workshop on Semantics and Services (AWOSS 10.2)*, 2010.
- Keynote talk: Leverage of Semantic Web Services for Practical Application: Creating Transferable Methodology with SADI Case Studies, *Atlantic Workshop on Semantics and Services (AWOSS 10.2)*, 2010.
- Knowledge Representation and Reasoning, *Web Publishing of Scientific Data and Services Training Course*, Fredericton, NB, May 2011.
- Web Services, *Web Publishing of Scientific Data and Services Training Course*, Fredericton, NB, May 2011.
- Knowledge Representation and Reasoning, *Web Publishing of Scientific Data and Services Training Course*, Vancouver, BC, October 2011.

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- the EPSRC grant “Efficient first-order theorem proving”
- an Overseas Research Student Award (ORS), 1999
- the Swedish TFR grant “Technology for Implementing Proof-Search”

## 9. Personalia

I was born in June 12, 1971, in Shadrinsk, Russia, and have Russian nationality. I am a Permanent Resident in Canada. I am married and have two daughters: a 9 year old and a 1 year old. My hobbies are hiking, camping, caving, fishing, cooking and history.