

Scientific CV of Dr Josef Urban

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Education: Charles University in Prague, Czech Republic

10/98 - 12/04	Ph.D. in Computer Science	Faculty of Mathematics and Physics
10/92 - 9/98	M.S. in Mathematics	Faculty of Mathematics and Physics
10/92 - 6/95	B.S. in Economics	Faculty of Social Sciences

Position:

9/09 - present	Postdoc researcher, Intelligent Systems, Radboud University Nijmegen
3/09 - 6/09	Visiting researcher, College of Engineering, American University in Armenia
4/06 - 10/07	Visiting Marie Curie researcher, University of Miami, Dept. of Comp. Sci.
7/05 - 3/09	Assistant professor, Dept. of Theoretical Comp. Science, Charles University
2/04 - 8/04, 2/02 - 8/02	Young Visiting Researcher, Dept. of Comp. Science, University of Bialystok

Research Interests:

Automated Reasoning, Formal Mathematics and Verification, Artificial Intelligence, Machine Learning, Semantic KBs, Automated Reasoning in Large Theories (ARLT), Combining deductive reasoning with inductive methods (learning) for ARLT

Selected Funding:

9/10 - ongoing	<i>Learning to Reason: a Machine Learning Approach for Computer-Assisted Reasoning</i> , NWO PhD funding, Co-investigator, EUR 205000
9/09 - ongoing	<i>MathWiki a Web-based Collaborative Authoring Environment for Formal Proofs</i> , NWO, Postdoc researcher, EUR 362406
4/06 - 6/08	<i>Automated Reasoning in Large Formal Mathematical Knowledge Bases</i> , Marie-Curie Fellowship, (MOIF-CT-2005-21875), Principal investigator, EUR 176076.5
4/05 - 12/06	<i>Tools and Formats for Automated Theorem Proving in Large Mathematical Knowledge Bases</i> , Charles University grant (205-10/203336), Co-investigator, CZK 553000
2/04 - 8/04,	<i>CALCULEMUS</i> , European Marie-Curie Research Training Network –
2/02 - 8/02	– (HPRN-CT-2000-00102), Young Visiting Researcher

Selected Journal Publications:

- J. Urban, S. Trac, G. Sutcliffe, and Y. Puzis. Combining Mizar and TPTP Semantic Presentation and Verification Tools. *Studies in Logic, Grammar and Rhetoric*, 18(31):121–136, 2009.
- J. Urban and G. Sutcliffe. ATP-based Cross-verification of Mizar Proofs: Method, Systems, and First Experiments. *Mathematics in Computer Science*, 2(2):231–251, 2008.
- J. Urban. MPTP 0.2: Design, Implementation, and Initial Experiments. *J. Autom. Reasoning*, 37(1-2):21–43, 2006.
- J. Urban. MoMM - Fast Interreduction and Retrieval in Large Libraries of Formalized Mathematics. *International Journal on Artificial Intelligence Tools*, 15(1):109–130, 2006.
- J. Urban. MizarMode - an Integrated Proof Assistance Tool for the Mizar Way of Formalizing Mathematics. *Journal of Applied Logic*, 4(4):414–427, 2006.
- J. Urban. MPTP - motivation, implementation, first experiments. *Journal of Automated Reasoning*, 33(3-4):319–339, 2004.
- J. Urban. Free Order Sorted Universal Algebra, *Formalized Mathematics*, 10(3):211–225, 2002
- J. Urban. Order Sorted Quotient Algebra, *Formalized Mathematics*, 10(3):201–210, 2002
- J. Urban. Homomorphisms of Order Sorted Algebras, *Formalized Mathematics*, 10(3):197–200, 2002
- J. Urban. Subalgebras of an Order Sorted Algebra. Lattice of Subalgebras, *Formalized Mathematics*,

10(3):189–196, 2002

- J. Urban. Order Sorted Algebras, *Formalized Mathematics*, 10(3):179–188, 2002
- J. Urban. Mahlo and Inaccessible Cardinals, *Formalized Mathematics*, 9(3):485–489, 2001
- J. Urban. Basic Facts about Inaccessible and Measurable Cardinals, *Formalized Mathematics*, 8(2):323–329, 2001

Selected Other Publications as Main Author:

- J. Urban, J. Vyskocil, and P. Stepanek. MaLeCoP: Machine Learning Connection Prover. *TABLEAUX 2011*, LNCS 6793: 263–277, 2011.
- J. Urban. An Overview of Methods for Large-Theory Automated Theorem Proving (Invited Paper). *ATE 2011*, CEUR 760: 3–8. 2011.
- E. Tsivtsivadze, J. Urban, H. Geuvers, T. Heskes. Semantic Graph Kernels for Automated Reasoning. *SDM 2011*: 795–803, SIAM / Omnipress, 2011.
- J. Urban, Content-based encoding of mathematical and code libraries. *MathWikis 2011*, CEUR 767: 49–53, 2011.
- D. Kuehlwein, J. Urban, E. Tsivtsivadze, H. Geuvers, and T. Heskes. Multi-Output Ranking for Automated Reasoning. *KDIR 2011*, (accepted).
- J. Alama, K. Brink, L. Mamane and J. Urban. Large Formal Wikis: Issues and Solutions, *Calculamus/MKM 2011*, LNCS 6824: 133–148, 2011.
- J. Urban, K. Hoder, and A. Voronkov. Evaluation of Automated Theorem Proving on the Mizar Mathematical Library. *ICMS 2010*, LNCS 6327: 155–166, 2010.
- J. Urban, J. Alama, P. Rudnicki, and H. Geuvers. A Wiki for Mizar: Motivation, Considerations, and Initial Prototype. *MKM 2010*: LNCS 6167: 455–469, 2010
- J. Vyskocil, D. Stanovsky, and J. Urban. Automated Proof Compression by Invention of New Definitions. *LPAR 2010*, LNAI 6355, 2010.
- J. Urban and G. Sutcliffe. Automated Reasoning and Presentation Support for Formalizing Mathematics in Mizar. *AISC 2010*, LNCS 6167: 132–146, 2010.
- J. Urban, G. Sutcliffe, P. Pudlák, and J. Vyskocil. MaLAREa SG1 - Machine Learner for Automated Reasoning with Semantic Guidance. *IJCAR 2008*, LNCS 5195: 441–456, 2008.
- J. Urban and G. Sutcliffe. ATP Cross-verification of the Mizar MPTP Challenge problems. *LPAR 2007*, LNCS 4790: 546–560, 2007.
- J. Urban. MaLAREa: a Metasystem for Automated Reasoning in Large Theories. *ESARLT 2007*, CEUR 257: 45–58. 2007.
- J. Urban. XML-izing Mizar: making semantic processing and presentation of MML easy. *MKM 2005*, LNAI 3863: 346–360. 2006.
- J. Urban and G. Bancerek. Presenting and Explaining Mizar. *UJTP 2006*, ENTCS 174: 63–74, 2007.
- G. Bancerek and J. Urban. Integrated semantic browsing of the Mizar Mathematical Library for authoring Mizar articles. *MKM 2004*, LNCS 3119: 44–57. 2004.
- J. Urban. Translating Mizar for first order theorem provers. *MKM 2003*, LNCS 2594: 203–215. 2003.

Edited Volumes

- James H. Davenport, William M. Farmer, Josef Urban and Florian Rabe, editors. Intelligent Computer Mathematics - 18th Symposium, Calculamus 2011, and 10th International Conference, MKM 2011, Bertinoro, Italy, July 18-23, 2011. Lecture Notes in Computer Science 6824, Springer 2011.
- Christoph Lange and Josef Urban, editors. Proceedings of the ITP 2011 Workshop on Mathematical Wikis, CEUR WS, Vol 767, ISSN 1613-0073.
- Josef Urban, Stephan Schulz, and Geoff Sutcliffe, editors. Proceedings of the CADE-21 Workshop on Empirically Successful Automated Reasoning in Large Theories, CEUR WS, Vol 257, ISSN 1613-0073.

Chapters in Collective Volumes

- Josef Urban, Jiri Vyskocil, and Petr Stepanek. Automaticke uvazovani (Automated Reasoning). In Olga Stepankova, editor, *Umela inteligence 6 (Artificial Intelligence 6)*, 2011, to appear.

Invited talks:

- *An Overview of Methods for Large-Theory Automated Theory Proving*, CADE23 Workshop on Automated Theory Engineering, Wroclaw, Poland, 31/07/2011
- *Large Formal Libraries: Birthplace of Strong AI?*, Deduction Seminar: Deduction at Scale, Max-Planck Institute for Informatics, Germany, 7-11/03/2011
- *Automated Reasoning over the Mizar Library*, AMS Special Session on Formal Math. for Mathematicians: Developing Large Repositories of Advanced Mathematics, New Orleans, USA, 6-9/01/2011
- *Automation and AI Tools for Mizar*, Symposium and General Assembly of Mizar Japan, Tokyo, 06/09/2010
- *AI Methods in Automated Reasoning*, ISLA 2010, Hyderabad, India, 25-28/01/2010
- *Automated Reasoning for Mizar: AI through Knowledge Exchange*, KEAPPA and IWIL, Qatar, 22/10/2008.
- *Accessing Mizar and its Semantics on the Web*, ICMS'2006, Castro Urdiales, Spain, 1-3/09/2006.

Prizes and awards:

- FOF category of the 2011 CASC competition in Wroclaw: 3rd place of the E-MaLeS system
- MZR category of the 2008 CASC competition in Sydney: 1st place of the MaLaRea system
- The Annual SUMO Reasoning Prizes at CASC (2008): 2nd place of the MaLaRea system (\$1000)

Selected Service Activities:

- Journal editorial boards: Formalized Mathematics (since 2006), Central European J. of Computer Science (since 2010)
- Other journals reviewed for: J. of Automated Reasoning, International J. on Artificial Intelligence Tools, J. of Logic and Computation, J. of Applied Logic, Mathematics in Computer Science
- Programm Committee: CICM'11 (Systems track Chair), MathWikis'11 (co-chair), PAAR'10, MIPS'10, MKM'09, PAAR'09, KEAPPA'08, PAAR'08, ESHOL'08, ESARM'08, PLMMS'08, ESARLT'07 (co-chair), PLMMS'07
- Graduate students: K. Hoder (MS), O. Kuncar (MS/PhD), Vl. Sisma (PhD), Daniel Kuehlwein (PhD)
- Professional Societies: Association for Automated Reasoning, Association of Mizar Users (Head of the Licensing Committee)

Teaching:

 (Charles University in Prague, Radboud University Nijmegen)

- Lectures: *Automated Reasoning and Theorem Proving, Formalization and Verification of Mathematics*
- Exercises: *Propositional and Predicate Logic, Non-procedural Programming, Analyses of Algorithms*
- Seminars: *Automated Theorem Proving*

Other academic and educational activities:

- Founded the ATP and ITP courses and seminar at Charles Univ. in Prague. Co-founded (with P. Stepanek) the Automated Reasoning Group¹ there. Started cooperation with other ATP and ITP groups, recommended several members to PhD positions in them. The group members and alumni include: P. Pudlak, J. Vyskocil, M. Janota (ESC Java - Dublin, Lisboa), J. Jakubuv (Heriot-Watt University), M. Suda (SPASS - MPI Saarbrucken), K. Hoder (Vampire - U. of Manchester), O. Kuncar.

Languages:

Czech (native), English (fluent), Polish (fluent), German (advanced), Russian (advanced), French (intermed.)

¹<http://arg.mff.cuni.cz/>

Selected Projects Implemented:

- **Machine Learner for Automated Reasoning:** (MaLAREa) combining deductive ATP and counter-example finding with machine learning in a closed loop. The strongest existing meta-system for automated reasoning with large amount of previous proof knowledge. MaLAREa solves 64% problems of the MPTP Challenge,² in comparison to 31% - 32% solved by state-of-art ATPs SPASS and Vampire.
- **MPTP:** Mizar Problems for Theorem Proving. Project bringing the largest formal mathematical library to the world of automated reasoning and related AI methods. Translation of Mizar logic and library to first-order ATP formats, preserving completeness and correctness, and providing consistent namespaces for symbols and theorems. That in turn allows machine learning from the proofs in the whole library, and makes research in combined ATP/AI metasystems like MaLAREa possible.
- **MPTP Challenge:** Design and implementation (with G. Sutcliffe) of the first large-theory AI/ATP benchmark³. This gave rise to the Large Theory Batch division of the annual CASC ATP competition.
- **Mizar, HOL Light, and Isabelle proof advisors:** Used machine learning on the tens of thousands of proofs in the large Mizar Mathematical Library to train a lemma-selection advisor. Similar work for Hales' proof of Jordan theorem in HOL, and for Isabelle (experimental). Combining the advisors with ATP systems to provide strong methods for reasoning over large complex theories.
- **Machine Learning Connection Prover:** (MaLeCoP - with Jiri Vyskocil) A connection tableaux prover using machine learning from a large body of solved problems and successful proof decisions to guide the internal ATP proof search process.
- **MoMM:** System using ATP indexing methods for fast interreduction of ca. one million mathematical propositions, and for real-time retrieval of relevant information from that knowledge base. Integration into the Emacs authoring environment for Mizar, its use for real-time searching of the Mizar library.
- **Formal mathematical wiki for Coq and Mizar:** Wikis for collaborative editing, verification, versioning, and web-presentation of computer-verified mathematics. Ongoing NWO-funded project.⁴
- **E-MaLeS:** Machine Learning of Strategies for E prover (with D. Kuhlwein and E. Tsvitvadze). Using machine learning methods to find optimal strategies for the E ATP system. Ongoing project.
- **MizarMode:** Authoring environment for Mizar, used by the majority of Mizar authors. Integrates number of proof assistance methods, searching and presentation tools, AI and ATP advisors.
- **MizAR web services:** ATP, verification, and presentation service for Mizar⁵. Provides: article verification, linked HTML presentation, ATP solving and explanation of Mizar problems, lemma suggestion.
- **XML-ization of Mizar:** XML-based re-implementation of Mizar internal format and datastructures. Used by a number of projects to understand and link with Mizar.
- **Otter2Mizar:** Tool automatically translating the Otter and Prover9 proofs into Mizar. This allows import of ATP proofs back to Mizar and their Mizar verification.
- **Formalization of the theory of order sorted algebras:** Developed order sorted algebras, their subalgebras, homomorphisms, quotient and free (term) algebras in Mizar.
- **Formalization of the theory of large cardinals:** Formal Mizar development including proofs that measurable and Mahlo cardinals are inaccessible, and that inaccessible cardinals give a model of ZF.

²The only ATP benchmark with machine learning allowed. The CASC-LTB contest omits learning since 2009, for simplicity.

³<http://www.tptp.org/MPTPChallenge/>

⁴<http://mws.cs.ru.nl/mwiki/>, <http://mws.cs.ru.nl/cwiki/>, www.fnds.cs.ru.nl/fndswiki/Research/MathWiki

⁵<http://mws.cs.ru.nl/~mptp/MizAR1096.html>