ASHISH SABHARWAL

Research Associate
Dept. of Computer Science
5160 Upson Hall, Cornell University
Ithaca, NY 14853-7501, U.S.A.

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CURRENT POSITION

Cornell University, Ithaca, NY, U.S.A.
RESEARCH ASSOCIATE — Sep 2008 – present
Dept. of Computer Science and Institute for Computational Sustainability (ICS)

EDUCATION

Cornell University, Ithaca, NY, U.S.A.
Postdoctoral Associate, Intelligent Information Systems Institute (IISI) — Nov 2005 – Aug 2008
Supervisors: *Profs. Carla P. Gomes* and *Bart Selman*

University of Washington, Seattle, WA, U.S.A.
Ph.D., Computer Science and Engineering (GPA 3.89/4.0) — 2001 – 2005
M.S., Computer Science and Engineering — 1998 – 2001
Advisors: *Profs. Paul Beame* and *Henry Kautz*

Indian Institute of Technology (IIT), Kanpur, India
B.Tech., Computer Science and Engineering (CPA 9.4/10.0) — 1994 – 1998
Project Supervisor: *Dr. Manindra Agrawal*

AWARDS AND ACHIEVEMENTS

Best Paper Awards

IJCAI-JAIR	Runner-up, best paper prize for 2003-2008	2008
AAAI-06	21st National Conference on Artificial Intelligence, Boston, MA	2006
CP-06	12th Intl. Conference on Constraint Programming, Nantes, France	2006

Best Paper Nominations

AAAI-07	22nd Conference on Artificial Intelligence, Vancouver, BC	2007
IJCAI-07	20th Intl. Joint Conference on Artificial Intelligence, Hyderabad, India	2007
UAI-07	23rd Conference on Uncertainty in Artificial Intelligence, Vancouver, BC	2007
ICAPS-06	Intl. Conference on Automated Planning and Scheduling, Cumbria, U.K.	2006

Scholarships and Other

Jhamandas Watumull Scholarship, University of Washington, Seattle	2002, 2005
Research Assistantship and Teaching Assistantship, University of Washington, Seattle	1998 – 2005
National Talent Search Scholarship, India	1992 – 1998
Gold Medal, National Standard Examination in Physics, India	1994
Certificate of Merit in English, Mathematics, and Physics awarded to 0.1% by Central Board of Secondary Education, India	1994
International Mathematics Olympiad Training and Selection Program, Mumbai, India	1993 – 1994
All India 24th Rank in IIT Entrance Examination (over 60,000 candidates)	1994

RESEARCH INTERESTS

My research is driven by combinatorial reasoning applications in Artificial Intelligence (AI), and draws upon an extensive background in Theoretical Computer Science. I am interested in developing scalable and robust automated reasoning technology that will allow computers to act intelligently in increasingly complex real-world settings and in competitive and uncertain environments.

Focus areas: combinatorial methods (SAT, CSP, QBF), probabilistic inference (BP, SP), multi-agent reasoning, constraint programming, connections to statistical physics, game theory, algorithm design, complexity

PUBLICATIONS

REFEREED PUBLICATIONS

[upcoming]

CPAIOR-09: *Backdoors to Combinatorial Optimization: Feasibility and Optimality.* B. Dilkina, C.P. Gomes, Y. Malitsky, A. Sabharwal, M. Sellmann. 6th Intl. Conf. on Integration of AI and OR Techniques in Constraint Programming, Pittsburgh, PA, May 2009.

SAC-09: *Message-Passing and Local Heuristics as Decimation Strategies for Satisfiability.* L. Kroc, A. Sabharwal, B. Selman. 24th Annual ACM Symp. on Applied Computing, Honolulu, HI, Mar 2009.

IJCAI-09 (under review): *Integrating Systematic and Local Search Paradigms: A New Strategy for MAX-SAT*. L. Kroc, A. Sabharwal, B. Selman. 21st Intl. Joint Conf. on AI. Under review.

SAT-09 (under review): *Relaxed DPLL Search for MaxSAT*. L. Kroc, A. Sabharwal, B. Selman. 12th Intl. Conf. on Theory & Applications of Satisfiability Testing. Under review.

SAT-09 (under review): *Backdoors in the Context of Learning*. B. Dilkina, C.P. Gomes, A. Sabharwal. 12th Intl. Conf. on Theory & Applications of Satisfiability Testing. Under review.

Constraints-09 (journal): *New Filtering Algorithms for Combinations of Among Constraints*. W.-J. van Hoeve, G. Pesant, L.-M. Rousseau, A. Sabharwal. Constraints Journal. In press.

CGTA-09 (journal): *Floodlight Illumination of Infinite Wedges*. M. Cary, A. Rudra, A. Sabharwal, E. Vee. Computational Geometry: Theory and Applications, journal. In press.

AMAI (journal, under review): *Tradeoffs in the Complexity of Backdoor Detection.* B. Dilkina, C.P. Gomes, A. Sabharwal. Annals of Mathematics and Artificial Intelligence. Under review.

AOR (journal, under review): *Leveraging Belief Propagation, Backtrack Search, and Statistics for Model Counting.* L. Kroc, A. Sabharwal, B. Selman. Annals of Operations Research. Under review.

AOR (journal, under review): *Bounds Consistency Filtering for Pair-Atmost1*. W.-J. van Hoeve, A. Sabharwal. Annals of Operations Research. Under review.

JAIR (journal, under review): *Friends or Foes? On Planning as Satisfiability and Abstract CNF Encodings*. C. Domshlak, J. Hoffmann, A. Sabharwal. Journal of Artificial Intelligence Research.

PNAS (journal, in preparation): *Reasoning About Solution Clusters Using Message Passing Algorithms*. L. Kroc, A. Sabharwal, B. Selman. In preparation for Proc. of the National Academy of Sciences.

Filtering the Length-Lex Set Partition Constraint. W.-J. van Hoeve, A. Sabharwal. In preparation.

[2008]

NIPS-08: *Counting Solution Clusters in Graph Coloring Problems Using Belief Propagation*. L. Kroc, A. Sabharwal, B. Selman. 22nd Conf. on Neural Info. Processing Systems, Vancouver, BC, Dec 2008.

CPAIOR-08: *Leveraging Belief Propagation, Backtrack Search, and Statistics for Model Counting.* L. Kroc, A. Sabharwal, B. Selman. 5th Intl. Conf. on Integration of AI and OR Techniques in Constraint Programming, Paris, France, May 2008. Also in ISAIM-08.

CPAIOR-08: *Connections in Networks: A Hybrid Approach*. C.P. Gomes, W.-J. van Hoeve, A. Sabharwal.

CPAIOR-08: *Filtering Atmost1 on Pairs of Set Variables*. W.-J. van Hoeve, A. Sabharwal.

Constraints-08 (journal): *SymChaff: Exploiting Symmetry in a Structure-Aware Satisfiability Solver*. A. Sabharwal. Constraints Journal. DOI: 10.1007/s10601-008-9060-1, SpringerLink, Oct 2008.

[2007]

CP-07: *Tradeoffs in the Complexity of Backdoor Detection.* B. Dilkina, C.P. Gomes, A. Sabharwal. 13th Intl. Conf. on Principles and Practice of Constraint Programming, Providence, RI, Sep 2007.

UAI-07: *Survey Propagation Revisited.* L. Kroc, A. Sabharwal, B. Selman. 23rd Conf. on Uncertainty in Artificial Intelligence, Vancouver, BC, July 2007.

AAAI-07: *Counting CSP Solutions Using Generalized XOR Constraints.* C.P. Gomes, W.-J. van Hoeve, A. Sabharwal, B. Selman. 22nd Conf. on Artificial Intelligence, Vancouver, BC, July 2007.

AAAI-07: *The Impact of Network Topology on Pure Nash Equilibria in Graphical Games.* B. Dilkina, C.P. Gomes, A. Sabharwal.

SAT-07: *Short XORs for Model Counting: From Theory to Practice.* C.P. Gomes, J. Hoffmann, A. Sabharwal, B. Selman. 10th Intl. Conf. Theory & Apps. of Sat. Test., Lisbon, Portugal, May 2007.

CPAIOR-07: *Connections in Networks: Hardness of Feasibility versus Optimality.* J. Conrad, C.P. Gomes, W.-J. van Hoeve, A. Sabharwal, J. Suter. 4th Intl. Conf. on Integration of AI and OR Techniques in Constraint Programming for Comb. Optimization Problems, Brussels, Belgium, May 2007.

IJCAI-07: *From Sampling to Model Counting*. C.P. Gomes, J. Hoffmann, A. Sabharwal, B. Selman. 20th Intl. Joint Conf. on Artificial Intelligence, Hyderabad, India, Jan 2007.

Complexity-07 (journal): *Resolution Complexity of Independent Sets and Vertex Covers in Random Graphs*. P. Beame, R. Impagliazzo, A. Sabharwal. Computational Complexity Journal, Dec 2007.

[2006]

NIPS-06: *Near-Uniform Sampling of Combinatorial Spaces Using XOR Constraints*. C.P. Gomes, A. Sabharwal, B. Selman. 20th Conf. on Neural Info. Processing Systems, Vancouver, BC, Dec 2006.

CP-06: *Revisiting the Sequence Constraint*. W.-J. van Hoeve, G. Pesant, L.-M. Rousseau, A. Sabharwal. 12th Intl. Conf. on Principles and Practice of Constraint Programming, Nantes, France, Sep 2006.
Best Paper Award.

SAT-06: *QBF Modeling: Exploiting Player Symmetry for Simplicity and Efficiency*. A. Sabharwal, C. Ansotegui, C.P. Gomes, J.W. Hart, B. Selman. 9th Intl. Conf. on Satisfiability, Seattle, Aug 2006.

AAAI-06: *Model Counting: A New Strategy for Obtaining Good Bounds*. C.P. Gomes, A. Sabharwal, B. Selman. 21st Natl. Conf. on Artificial Intelligence, Boston, MA, July 2006.
Outstanding Paper Award, two awards out of nearly 800 submissions.

ICAPS-06: *Friends or Foes? An AI Planning Perspective on Abstraction and Search*. J. Hoffmann, A. Sabharwal, C. Domshlak. 16th Intl. Conf. on Auto. Planning & Scheduling, Cumbria, U.K., 2006.

[2005 and earlier]

AAAI-05: *SymChaff: A Structure-Aware Satisfiability Solver*. A. Sabharwal. 20th Natl. Conf. on Artificial Intelligence, Pittsburgh, PA, July 2005.

JAIR-04 (journal): *Towards Understanding and Harnessing the Potential of Clause Learning*. P. Beame, H. Kautz, A. Sabharwal. Journal of Artificial Intelligence Research, Dec 2004.
Runner-up for IJCAI-JAIR Best Paper Prize for years 2003-2008,

SICOMP-04 (journal): *Bounded-Depth Frege Lower Bounds for Weaker Pigeonhole Principles*. J. Buresh-Oppenheim, P. Beame, T. Pitassi, R. Raz, A. Sabharwal. SIAM Journal on Computing, Dec 2004.

IJCAI-03: *Understanding the Power of Clause Learning*. P. Beame, H. Kautz, A. Sabharwal. 18th Intl. Joint Conf. on Artificial Intelligence, Acapulco, Mexico, Aug 2003.

SAT-03: *Using Problem Structure for Efficient Clause Learning*. A. Sabharwal, P. Beame, H. Kautz. 6th Intl. Conf. on Theory and Applications of Satisfiability Testing, Portofino, Italy, May 2003.

FOCS-02: *Bounded-depth Frege Lower Bounds for Weaker Pigeonhole Principles*. J. Buresh-Oppenheim, P. Beame, T. Pitassi, R. Raz, A. Sabharwal. 43rd Symp. Foundations of CS, Vancouver, Nov 2002.

CCC-01: *Resolution Complexity of Independent Sets in Random Graphs*. P. Beame, R. Impagliazzo, A. Sabharwal. 16th Annual Conf. on Computational Complexity, Chicago, IL, June 2001.

BOOK CHAPTERS AND SURVEYS

Satisfiability Solvers. C.P. Gomes, H. Kautz, A. Sabharwal, B. Selman. In Handbook of Knowledge Representation, in the series Foundations of Artificial Intelligence, vol. 3, editors F. van Harmelen, V. Lifschitz, B. Porter. Elsevier. 2008.

Incomplete Algorithms (for Satisfiability). H. Kautz, A. Sabharwal, B. Selman. In Handbook of Satisfiability, editors A. Biere, M. Heule, H. van Maaren, T. Walsh. IOS Press. 2009.

Model Counting (for Satisfiability). C.P. Gomes, A. Sabharwal, B. Selman. In Handbook of Satisfiability, editors A. Biere, M. Heule, H. van Maaren, T. Walsh. IOS Press. 2009.

Exploiting Runtime Variation in Complete Solvers (for Satisfiability). C.P. Gomes, A. Sabharwal. In Handbook of Satisfiability, editors A. Biere, M. Heule, H. van Maaren, T. Walsh. IOS Press. 2009.

Artificial Intelligence and Complexity. A. Sabharwal, B. Selman. In Encyclopedia of Complexity and Systems Science, editor R. Meyers. Springer. In preparation.

WORKSHOPS, INVITED TALKS, OTHER WORK

UBC, 2008 (invited talk): Laboratory of Computational Intelligence (LCI) Forum, University of British Columbia, Vancouver, BC, Dec 2008.

CMU, 2008 (invited talk): Carnegie Mellon University, Pittsburgh, PA, 2008.

UC Merced, 2008 (invited talk): University of California, Merced, CA, 2008.

PhysDIS, 2008 (invited talk): Workshop on Physics of Distributed Information Systems (PhysDIS), Nordic Institute for Theoretical Physics (NORDITA), Sweden, Stockholm, May 2008.

INFORMS-08: *Hidden Structure in Constraint Reasoning Problems*. B. Dilkina, C.P. Gomes, A. Sabharwal (presenter). INFORMS Annual Meeting, Washington, DC, Oct 2008.

INFORMS-08: *Solution Counting Methods for Combinatorial Problems.* C.P. Gomes, W.-J. van Hoeve, L. Kroc, A. Sabharwal (presenter), B. Selman.

INFORMS-08: *Counting CSP Solutions Using Generalized XOR Constraints.* C.P. Gomes, W.-J. van Hoeve (presenter), A. Sabharwal, B. Selman.

AAEA-08: Optimal Corridor Design for Grizzly Bear in the U.S. Northern Rockies. J.F. Suter (presenter), J. Conrad, C.P. Gomes, W.-J. van Hoeve, A. Sabharwal. American Agricultural Economics Association Annual Meeting, Orlando, FL, Jul 2008.

ISAIM-08: *Tradeoffs in Backdoors: Inconsistency Detection, Dynamic Simplification, and Preprocessing*. B. Dilkina, C.P. Gomes, A. Sabharwal. 10th Intl. Symp. on AI and Math, Ft. Lauderdale, FL, Jan 2008. Initial results at CP-07.

ModRef-07: *Two Set Constraints for Modeling and Efficiency*. W.-J. van Hoeve, A. Sabharwal. 6th Intl. Workshop on Constraint Modeling and Reformulation, at CP-07, Providence, RI, Sep 2007.

INFORMS-07: *Hidden Structure in Combinatorial Problems*. C.P. Gomes, A. Sabharwal (presenter). INFORMS Annual Meeting, Seattle, WA, Nov 2007.

INFORMS-07: *Filtering Algorithms for the Sequence Constraint*. W.-J. van Hoeve (presenter), G. Pesant, L.-M. Rousseau, A. Sabharwal.

INFORMS-06: *Streamlining Reasoning for Solution Finding and Counting.* C.P. Gomes (presenter), A. Sabharwal, M. Sellmann, B. Selman. INFORMS Annual Meeting. Pittsburgh, PA, Nov 2006.

ISWC-07: *Sampling and Soundness: Can We Have Both?* C.P. Gomes, J. Hoffmann, A. Sabharwal, B. Selman. 6th Intl. Semantic Web Conference, Busan, Korea, Nov 2007.

AISP-07: *Empirical Validation of the Relationship Between Survey Propagation and Covers in Random 3-SAT*. L. Kroc, A. Sabharwal, B. Selman. Workshop on Algorithms, Inference, and Statistical Physics, Santa Fe, NM, May 2007.

NESCAI-07: *Sparse Message Passing Algorithms for Weighted Max-SAT*. A. Culotta, A. McCallum, B. Selman, A. Sabharwal. 2nd North East Student Colloq. on AI, Ithaca, NY, Apr 2007.

PH.D. THESIS: *Algorithmic Applications of Propositional Proof Complexity*, October 2005.
Advisors: Prof. Paul Beame and Prof. Henry Kautz

Model Checking: Two Decades of Novel Techniques and Trends.
General Examination Report, University of Washington, Seattle, May 2002.

Notes on Proof Complexity. Scribed lectures for Summer School, Institute for Advanced Study / Park City Math. Inst. (IAS/PCMI), Princeton, Aug 2000, IAS/PCM Series, volume 10, pages 199-246, 2004.

RESEARCH POSITIONS AND SUMMER WORK

RESEARCH ASSOCIATE, CORNELL UNIVERSITY, Ithaca, NY, U.S.A. Sep 2009 – present

Computational Sustainability (NSF): Funded by the National Science Foundation under the Expeditions in Computing program, this project, directed by Prof. Carla Gomes, has the overarching vision that computer scientists can — and should — play a key role in increasing the efficiency and effectiveness of the way we manage and allocate our natural resources, while enriching and transforming Computer Science. The project seeks to employ state-of-the-art computational methods to challenging problems in the arena of sustainability, ranging from wildlife preservation (e.g., by designing movement corridors or removing carefully selected fish passage barriers) to renewable energy (e.g., biofuels production and distribution) to balancing socio-economic demands and the environment (e.g., optimizing rotational opening and closing of fisheries).

POSTDOCTORAL ASSOCIATE, CORNELL UNIVERSITY, Ithaca, NY, U.S.A. Sep 2005 – Aug 2008

Supervisors: Profs. Bart Selman and Carla P. Gomes

Real-World Reasoning (DARPA): Funded by the Defense Advanced Research Projects Agency, this project seeks to significantly improve the scalability and robustness of general reasoning technology to address large-scale adversarial and contingency settings. This work achieved orders of magnitude improvement over prior technology by introducing novel problem modeling and solution techniques.

Beyond Traditional SAT Technology (NSF): Funded by the National Science Foundation under the Robust Intelligence program, this project aims at new scientific advances in automated reasoning systems that go beyond traditional combinatorial search and apply in competitive and unpredictable settings. This work explored connections with probabilistic reasoning and developed several state-of-the-art practical tools for counting and uniform sampling problems in intricate combinatorial spaces.

RESEARCH ASSISTANT, UNIVERSITY OF WASHINGTON, Seattle, WA, U.S.A. 2000 – 2005

Advisors: Profs. Paul Beame and Henry A. Kautz

Proof Complexity: Studied 'resolution' as a proof system and developed techniques to show that even approximately solving a majority of the instances of some natural structured problems are hard for this system. In separate work, contributed to proving lower bounds for a stronger proof system.

Satisfiability (SAT) Algorithms: Introduced the first formal framework capturing the most widely used class of complete algorithms for propositional satisfiability. Proposed and built a state-of-the-art solver called SymChaff for exploiting structural symmetry in reasoning problems.

PARTICIPANT AND SCRIBE, IAS/PCMI Summer School in Theoretical Computer Science Summer 2000
INSTITUTE FOR ADVANCED STUDY (IAS), Princeton, NJ, U.S.A.

INTERN, MICROSOFT RESEARCH (MSR), Redmond, WA, U.S.A. Summer 1999

Supervisor: Dr. John Manferdelli, Anti-Piracy Group

Digital Rights Management: Designed methods that use control- and data-flow analysis on binary program code to embed hard-to-break license authentication protocols in arbitrary programs.

VISITING STUDENTS RESEARCH PROGRAM Summer 1997
TATA INSTITUTE OF FUNDAMENTAL RESEARCH (TIFR), Mumbai, India

Supervisor: Dr. Paritosh K. Pandya, Theoretical Computer Science Group

Verification: Explored efficient monadic second order logic operators useful for verification, by exploiting connections between logic and automata-theoretic frameworks.

B.TECH. PROJECT, INDIAN INSTITUTE OF TECHNOLOGY (IIT), Kanpur, India 1997 – 1998

Project Supervisor: Dr. Manindra Agrawal

Circuit complexity: Proved lower bounds on the size of small depth monotone circuits for the 3-clique problem using combinatorial techniques.

TEACHING EXPERIENCE

TUTORIAL PRESENTATIONS

Satisfied by Message Passing: Probabilistic Techniques for Combinatorial Probs.: AAAI Conference, 2008

Combinatorial Problems (series of 3 lectures) : Kavli Instt. for Theoretical Physics, China, 2008
I. Solving II. Counting and Sampling III. QBF Reasoning

Beyond Traditional SAT Reasoning : AAAI Conference, 2007
QBF, Model Counting, and Solution Sampling

Quantified Boolean Formula (QBF) Reasoning : DARPA, 2007

LECTURER, University of Washington, Seattle, WA, U.S.A. Fall 2003

Organized and taught with the help of two teaching assistants an undergraduate Data Structures course to a class of 46 students. Increased effectiveness of lectures by using a new tablet PC based interactive slide system. Was praised for enthusiasm and knowledge. Overall student evaluation rating: 4.2/5.0.

TEACHING ASSISTANT, University of Washington, Seattle, WA, U.S.A. 1998 – 2002

Graduate level courses	:	Design and Analysis of Algorithms, Applied Algorithms, Computability and Complexity
Courses involving teaching	:	Introduction to Computing, Data Structures, Machine Organization
Other courses	:	Introduction to Formal Models, Intro. to Compiler Construction, Algorithms and Computational Complexity

TUTOR, University of Washington, Seattle, WA, U.S.A.

Provided one-on-one volunteer tutoring help to several undergraduate computer science students.

PROFESSIONAL EXPERIENCE

Proposal Writing, Grant Management

National Science Foundation (NSF) [Robust Intelligence / Info & Intelligent Systems / Expeditions]
Defense Advanced Research Projects Agency (DARPA)
Air Force Office of Scientific Research (AFOSR)
Kodak Research Laboratories

Program Committees

IJCAI-09	: Intl. Joint Conference on Artificial Intelligence
CPAIOR-09	: Intl. Conference on Integration of AI and OR Techniques in Constraint Programming
CP-09	: Intl. Conference on Principles and Practice of Constraint Programming
AAAI-08/07/06	: Conference on Artificial Intelligence
Counting-08	: Workshop on Counting Problems in CSP and SAT, and other Neighboring Problems
ISC-07	: Intl. Symmetry Conference
SAT-06	: Intl. Conference on Theory & Applications of Satisfiability Testing

Journal Reviews

J. of Artificial Intelligence Research (JAIR), Artificial Intelligence J. (AIJ),
J. on Satisfiability, Boolean Modeling and Computation (JSAT),
Constraints J., Transactions on Computational Logic, Acta Informatica

Conference Reviews

AAMAS-09 AAAI-08/07/06/05 SAT-07/06 CPAIOR-07 CP-08/06 ISC-07 NESCAI-07/06
ISAIM-08 STACS-07 ITNG-07 PRICAI-06 CSR-06 SASIMI-06 ISVLSI-06 SAC-06

Member

Association for the Advancement of Artificial Intelligence (AAAI)
Constraint Programming Society in North America (CPNA)
New York Academy of Sciences (NYAS)

PERSONAL INFORMATION

Nationality: Indian, currently on H-1B work visa in the U.S.
Non-academic interests: hiking, skiing, martial arts (karate black belt), classical music

REFERENCES

Prof. Carla P. Gomes (Postdoc. co-supervisor)
Director, Institute for Computational Sustainability
Department of Computer Science — Ph: 607·255·9189
5133 Upson Hall, Cornell University — *gomes@cs.cornell.edu*
Ithaca, NY 14853-7501 — http://www.cs.cornell.edu/gomes

Prof. Bart Selman (Postdoc. co-supervisor)
Department of Computer Science — Ph: 607·255·5643
4148 Upson Hall, Cornell University — *selman@cs.cornell.edu*
Ithaca, NY 14853-7501 — http://www.cs.cornell.edu/selman

Prof. Paul Beame (Ph.D. co-advisor)
Computer Science and Engineering — Ph: 206·543·5114
University of Washington, Box 352350 — *beame@cs.washington.edu*
Seattle, WA 98195-2350 — http://www.cs.washington.edu/homes/beame

Prof. Henry Kautz (Ph.D. co-advisor)
Chair, Department of Computer Science — Ph: 585·275·5671
University of Rochester, Box 270226 — *kautz@cs.rochester.edu*
Rochester, NY 14627 — http://www.cs.rochester.edu/u/kautz