

## Chitta Baral

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## Research Interests

- **Bioinformatics** (in particular, AI and Database applications to Bioinformatics); Representation and reasoning about signal pathways, protein-protein interactions and gene networks. Learning causal connection between genes from micro-array data. Knowledge extraction from Biological texts.

- **Knowledge representation, reasoning and declarative problem solving.** Declarative problem solving and optimizations (with applications to planning, job-shop scheduling, tournament scheduling, supply chain planning, combinatorial auctions, product configuration, diagnosis, explanation generation and constraint satisfaction problems), Knowledge Representation and Non-monotonic Reasoning (with applications to common-sense reasoning, reasoning with defaults, reasoning with incomplete information, reasoning with priorities and preferences, and inheritance hierarchies), Logic Programming, Temporal Reasoning, Combining knowledge bases, and AI in general.

- **A systematic approach to designing and analyzing autonomous agents.** (mobile robots, robot control – formal characterization and automatic generation, cognitive robotics, reasoning about actions, concurrent actions, complex actions, actions with causal effects, actions with non-deterministic effects, narratives, sensing actions, actions with probabilistic effects, Bayes networks, Markov decision processes, Partially Observable Markov Decision Processes, etc.)

- **Active, deductive and incomplete databases and workflows.**

(Semantics of active databases, Formulating correctness of active databases, specification of the purpose of active databases and automatic derivation of active rules from this specification, modeling workflows as multiple co-operative agents, etc.)

- **Multimedia and Visualization.**

(Modeling of Multi-media data, object relational model, Multi-media database design using extended ER models, Modeling the web as a database, Visualization and display of multi-media data, etc.)

## Education

Doctor of Philosophy, Computer Science     August 1991.

University of Maryland, College Park, Maryland.

Dissertation: *Issues in Knowledge Representation : Semantics and Knowledge Combination.*

Advisor: Prof. Jack Minker.

Master of Science, Computer Science     May 1990.

University of Maryland, College Park, Maryland.

Bachelor of Technology with Honors, Computer Science and Engineering      May 1987.  
Indian Institute of Technology, Kharagpur, India.

## Professional Experience

**Professor:** (August 2002 - present) Department of Computer Science and Engineering, Arizona State University.

**Associate Professor:** (August 1999 - August 2002) Department of Computer Science and Engineering, Arizona State University.

**Visiting Scientist:** (June 99 - August 99) Department of Computer and Information Science, Linköping University, Sweden.

**Associate Professor:** (August 1996 - August 1999) Department of Computer Science, University of Texas at El Paso.

**Visiting Scientist:** (June 98 - August 98) i2 Technologies, Dallas. Worked on planning and scheduling methods for supply chain planners.

**Visiting Professor:** (Dec 1996 - Jan 97) Department of Computer Science, University of New South Wales, Sydney, Australia.

**Assistant Professor:** (August 1991 - August 1996) Department of Computer Science, University of Texas at El Paso.

**Graduate Research Fellow:** (August 1990 - June 1991) University of Maryland, College Park. Research towards my dissertation.

**Graduate Research Assistant:** (May 1988 - June 1991) Department of Computer Science, University of Maryland, College Park. Dissertation work on semantics of knowledge representation languages and theory of combining knowledge bases. Also investigated the use of semantic constraints to constrain the search space in a parallel logic programming environment.

**Teaching Assistant:** (August 87 - May 88) Department of Computer Science, University of Maryland, College Park. Assisted courses in Computer Architecture, Compiler Design and Data structures.

## Publications<sup>1</sup> and Submissions

### Books

- [1] C. Baral. Knowledge representation, reasoning and declarative problem solving. Cambridge University Press, 2003, ISBN 0521818028.

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<sup>1</sup>Electronic copies of selected papers are available through <http://www.public.asu.edu/~cbaral>

## Journal Articles

- [1] Xin Zhang, Seungchan Kim, Tie Wang and Chitta Baral. Joint learning of logic relationships for studying protein function using phylogenetic profiles and the Rosetta Stone method. To appear in *IEEE Transactions on Signal Processing*.
- [2] Tran Cao Son, Chitta Baral, Sheila McIlraith, and Nam Tran. Planning with domain-dependent knowledge of different kinds – an answer set programming approach. To appear in *ACM Transactions on Computational Logic*.
- [3] Nam Tran, Chitta Baral, Vinay Nagaraj and Lokesh Joshi. Knowledge-Based Framework for Hypothesis Formation in Biochemical Networks: application to the p53 network. *Bioinformatics*, 21: ii213-ii219. (Supplement for the papers of ECCB'2005)
- [4] C. Baral and Y. Zhang. Knowledge updates: Semantics and complexity issues. *Artificial Intelligence*. 164(1-2): 209-243 (2005).
- [5] Graciela Gonzalez, Chitta Baral and Michael Gelfond. Alan: An Action Language for Modelling Multimedia Presentations Using Non- Markovian Domains. *Studia Logica*. 79(1): 115-134 (2005)
- [6] Chitta Baral and Nam Tran. Representation and reasoning about evolution of the world in the context of reasoning about actions. *Studia Logica*. 79(1): 33-46 (2005)
- [7] C. Baral, K. Chancellor, Nam Tran, M. Berens, A. Joy and Nhan Tran. A knowledge based approach for representing and reasoning about signal networks. *Bioinformatics*. vol 20, supplement 1, pages i15-i22, Supplement for the long papers of ISMB/ECCB'04, 2004.
- [8] R. Trejo, J. Galloway, C. Sachar, V. Kreinovich, C. Baral and L. Tuan. From planning to searching for the shortest plan: an optimal translation. *International journal of uncertainty, fuzziness and knowledge-based systems*. 9 (6): 827-837, 2001.
- [9] G. Trajcevski, C. Baral, J. Lobo: Formalizing and Reasoning About the Requirements Specifications of Workflow Systems. *IJCIS* 10(4): 483-507 (2001)
- [10] T. Son and C. Baral. Formalizing sensing actions – a transition function based approach. In *Artificial Intelligence*, 125, 1-2, 19-93, 2001.
- [11] C. Baral, V. Kreinovich and R. Trejo. Computational complexity of planning and approximate planning in presence of incompleteness. In *Artificial Intelligence*, 122, 241-267, 2000.
- [12] C. Baral. Abductive reasoning through filtering. In *Artificial Intelligence*, 120 (1), 1-28, 2000.
- [13] C. Baral, A. Gabaldon and A. Proveti. Value minimization in Circumscription. In *Artificial Intelligence*, 102/2, 163-186, July 1998.
- [14] C. Baral, A. Gabaldon and A. Proveti. Formalizing narratives using nested circumscription. In *Artificial Intelligence*, 104/1-2, 107-164, Sept 1998.
- [15] C. Baral and T. Son. Relating theories of actions and reactive control. In *Electronic Transactions on Artificial Intelligence*, vol 2, issue 3-4, 211-271, July - December 1998.

- [16] C. Baral, M. Gelfond and O. Kosheleva. Expanding queries to incomplete databases by interpolating general logic programs. In *Journal of Logic Programming*, vol 35, 1998, 195-230.
- [17] C. Baral, G. Gonzalez and T. Son. Conceptual modeling and querying in multi-media databases. In *Multimedia Tools and Applications*, 7, 37-66 (1998).
- [18] C. Baral and Michael Gelfond. Reasoning about effects of concurrent actions. In *Journal of Logic Programming*, Vol 31(1-3), May 97, 85-117.
- [19] C. Baral. Embedding Revision Programs in Logic Programming Situation Calculus. In *Journal of Logic Programming*, vol 30(1), Jan 97, 83-97.
- [20] C. Baral, M. Gelfond and A. Proveti. Representing Actions: Laws, Observations and Hypothesis. In *Journal of Logic Programming*, Vol 31(1-3), May 97, 201-243.
- [21] C. Baral. Relating Logic programming theories of actions and partial order planning. In *Annals of Math and AI*, Vol. 21 (1997) Nos. 2-4.
- [22] C. Baral. Varying Selection Function to Relate Conditional Logics and Preferential Models. In *Fundamenta Informaticae*, vol 21, No. 4 (1994), 307-320.
- [23] C. Baral and M. Gelfond. Logic Programming and Knowledge Representation. In *Journal of Logic Programming*, 19,20:73-148, 1994.
- [24] C. Baral, S. Kraus, J. Minker and V. S. Subrahmanian. Combining Default Logic Databases. In *International Journal of Intelligent and Co-operative Information Systems*, vol. 3, No. 3, 319-348, 1994.
- [25] C. Baral and V. S. Subrahmanian. Duality between Alternative Semantics of Logic Programs and Nonmonotonic Formalisms. In *Journal of Automated Reasoning*, 10:399-420, 1993.
- [26] C. Ramamoorthy, D. Cooke and C. Baral. Maintaining the Truth of Specifications in Evolutionary Software. In *International Journal of Tools for Artificial Intelligence*, vol 2, No 1 (1993) 15-31.
- [27] C. Baral and V. S. Subrahmanian. Stable and Extension Class Theory for Logic Programs and Default Logics. In *Journal of Automated Reasoning*, 8: 345-366, 1992
- [28] C. Baral, J. Lobo and J. Minker. Generalized Disjunctive Well-founded Semantics for logic programs. In *Annals of Math and Artificial Intelligence*, 5 (1992) 89-132.
- [29] C. Baral, S. Kraus, J. Minker and V. S. Subrahmanian. Combining Knowledge Bases Consisting of First Order Theories. In *Computational Intelligence*, 8, 1, (1992), 45-71.
- [30] C. Baral, J. Minker and S. Kraus. Combining Multiple Knowledge Bases. In *IEEE Transactions on Knowledge and Data Engineering*, June 1991, volume 3, number 2, pages 208-221.

## Book Chapters (refereed)

- [1] C. Baral, Michael Gelfond and Richard Watson. Reasoning about actual and hypothetical occurrences of concurrent and non-deterministic actions. In *Dynamic Worlds: From the frame problem to knowledge management*, pages 73-107, Edited by, Remo Pareschi and Bertram Fronhofer, Kluwer Academic Publishers, 1999.
- [2] C. Baral and M. Gelfond. Reasoning agents in dynamic domains. In *Logic based AI*, editor J. Minker, Kluwer Academic Publishers, pgs 257-279, 2000.
- [3] C. Baral and M. Gelfond. Logic Programming and Reasoning about Actions. In *Handbook of Temporal Reasoning in AI*, editor M. Fisher, D. Gabbay and L. Vila, Elsevier Publications, 2005. pages 389-428.

## Edited Books/Proceedings/Special Issues

- [1] Chitta Baral, Gianluigi Greco, Nicola Leone, Giorgio Terracina: Logic Programming and Nonmonotonic Reasoning, 8th International Conference, LPNMR 2005, Diamante, Italy, September 5-8, 2005, Proceedings Springer 2005.
- [2] C. Baral, A. Proveti and T. Son. Introduction to the special issue on Programming with Answer Sets. *TPLP* 3(4-5): 387-391 (2003)
- [3] C. Baral and S. McIlraith. Proceedings of the Third International Cognitive Robotics Workshop. July 28, 2002.
- [4] C. Baral and M. Truszczyński. Proceedings of 8th International Workshop on Non-monotonic reasoning. April 9-11, 2000.
- [5] C. Baral and H. Mohanty. *CIT'99: Trends in Information Technology*, (Proceedings of the International Conference on Information Technology), 1999. Tata-McGrawHill Publishers. ISBN 0-07-463747-9.
- [6] C. Baral and R. Goldman. Proceedings of the AAAI 97 Workshop on Robots, Softbots and Immobots: Theories of action, planning and control.
- [7] C. Baral, V. Kreinovich and V. Lifschitz. Special issue on Logic programming, non-monotonic reasoning and reasoning about actions. *Annals of Math and AI*. Volume 21 (2-4), 1997.
- [8] C. Baral. Theories of action, planning and robot control: Bridging the gap. Papers from the 1996 Workshop. AAAI, August 1996. ISBN 1577350219.
- [9] C. Baral, M. Gelfond, J. Lobo and A. Rajasekar. Proceedings of the Workshop on Logic Programming with Incomplete Information. October 1993.

## Conference and Workshop Papers (refereed)

- [1] Lian Yu, Syed Toufeeq Ahmed, Graciela Gonzalez, Brandon Logsdon, Mutsumi Nakamura, Shawn Nikkila, Kalpesh Shah, Luis Tari, Ryan Wendt, Amanda Zeigler and Chitta Baral. Genomic information retrieval through selective extraction and tagging by the ASU-BioAI Group. Proceedings of the 2005 TREC Genomics track.

- [2] Luis Tari and Chitta Baral. Using AnsProlog with Link Grammar and WordNet for QA with deep reasoning. Proc. of AAAI'05 workshop on Inference for Textual Question Answering.
- [3] Chita Baral, Gregory Gelfond, Michael Gelfond and Richard Scherl. Textual Inference by combining multiple logic programming paradigms. Proc. of AAAI'05 workshop on Inference for Textual Question Answering.
- [4] Nam Tran and Chitta Baral. Issues in reasoning about cellular interactions: necessity of event ordering knowledge. Proc. of AAAI'05, 676-681.
- [5] Chitta Baral and Michael Gelfond. Reasoning about intended actions. Proc. of AAAI'05, 689-694.
- [6] Chitta Baral, Thomas Eiter and Jicheng Zhao. Using SAT and Logic Programming to Design Polynomial-Time Algorithms for Planning in Non-deterministic Domains. Proc. of AAAI'05, 575-583.
- [7] Carron Shankland, Nam Tran, Chitta Baral, and Walter Kolch. Reasoning about the ERK signal transduction pathway using BioSigNet-RR. In Computational Methods in Systems Biology (CMSB'05) 2005. 3-5 April 2005, Edinburgh, Scotland.
- [8] Xin Zhang, Chitta Baral, Seungchan Kim. An algorithm to learn causal connection between genes from steady state data: simulation and its application to melanoma dataset. Proc. of 10th Conference on Artificial Intelligence in Medicine (AIME 05) 23 - 27 July 2005 Aberdeen, Scotland. Pages 524-534.
- [9] Nam Tran, Chitta Baral, Vinay Nagaraj and Lokesh Joshi. Knowledge-Based Integrative Framework for Hypothesis Formation in Biochemical Networks. Proc. of the 2nd International Workshop on Data Integration in the Life Sciences, San Diego (DILS'05), July 20-22, 2005. Pages 121-136.
- [10] Chitta Baral, Prabhdeep Singh, Ravi Bhimavarapu, Hasan Davulcu, Huan Liu, Seungchan Kim, Mike Bittner and I.V. Ramakrishnan. BioLog: A Browser Based Collaboration and Resource Navigation Assistant for BioMedical Researchers. Proc. of the 2nd International Workshop on Data Integration in the Life Sciences (DILS'05), San Diego, July 20-22, 2005 Pages 19-30.
- [11] Chitta Baral, Hasan Davulcu, Mutsumi Nakamura, Prabhdeep Singh, Lian Yu and Luis Tari. Collaborative Curation of Data from Bio-medical Texts and Abstracts and its integration. Proc. the 2nd International Workshop on Data Integration in the Life Sciences (DILS'05), San Diego, July 2022, 2005. Pages 309-312. (poster paper)
- [12] Syed Toufeeq Ahmed, Deepthi Chidambaram, Hasan Davulcu and Chitta Baral. IntEx: A Syntactic Role Driven Protein-Protein Interaction Extractor for Bio-Medical Text. Proc. of BioLINK SIG: Linking Literature, Information and Knowledge for Biology, a Joint Meeting of The ISMB BioLINK Special Interest Group on Text Data Mining and The ACL Workshop on Linking Biological Literature, Ontologies and Databases: Mining Biological Semantics (Biolink'2005), Detroit, Michigan, June 24, 2005.
- [13] L. Tari, C. Baral and Partha Dasgupta. Understanding the global properties of functionally related gene networks using the gene ontology. In Proceedings of Pacific Symposium on Biocomputing 2005. (PSB'05), pages 209-220. World Scientific.

- [14] Lei Yu, Chitta Baral, Seungchan Kim, Jessica Rennert, Dominique B Hoelzinger, Michael E Berens and Huan Liu. Discriminative Gene Selection for Brain Tumor Migration. Poster in Pacific Symposium on Biocomputing 2005. (PSB'05)
- [15] C. Baral, Le-Chi Tuan, Xin Zhang, Tran Son. Regression With Respect to Sensing Actions and Partial States. In Proceedings of AAI'04, pages 556-561.
- [16] C. Baral and Jicheng Zhao. Goal specification in presence of non-deterministic actions. In Proceedings of ECAI'04, pages 273-277.
- [17] C. Baral and Nam Tran. Encoding probabilistic causal models in probabilistic action language PAL. In Proceedings of AAI'04, pages 305-310.
- [18] Tran Son, Chitta Baral, and Le-Chi Tuan. Adding Time and Intervals to Procedural and Hierarchical Control Specifications. In Proceedings of AAI'04, pages 92-97.
- [19] N. Tran and C. Baral. Reasoning about Triggered Actions in AnsProlog and its Application to Molecular Interactions in Cells. In Proceedings of KR'2004, pages 554-564.
- [20] C. Baral and T. Eiter. A Polynomial time algorithm for constructing k-maintainable policies. In Proceedings of ICAPS'2004, pages 111-121.
- [21] C. Baral, M. Gelfond and N. Rushton. Probabilistic reasoning with answer sets. In Proceedings of LPNMR7, 2004. pgs 21-33.
- [22] T. Son, P. Huy and C. Baral. Planning with Sensing Actions and Incomplete Information using Logic Programming. In Proceedings of LPNMR7, 2004. pgs 261-274.
- [23] C. Baral and Matt Barry. Goal specification using temporal logic in presence of non-deterministic actions. In Proc. Nonmonotonic Reasoning, Action, and Change (NRAC'03)
- [24] Chitta Baral and Nam Tran. Representation and reasoning about evolution of the world in the context of reasoning about actions. In Proc. Nonmonotonic Reasoning, Action, and Change (NRAC'03)
- [25] Chitta Baral and Nam Tran. Encoding probabilistic causal models in probabilistic action language PAL. In Proc. Nonmonotonic Reasoning, Action, and Change (NRAC'03).
- [26] C. Baral, K. Chancellor, Nam Tran and Nhan Tran. Representing and reasoning about signal networks: an illustration using NF $\kappa$ B dependent signal pathways. In Proceedings of Computational Systems Bioinformatics (CSB2003), 2003, poster paper, pages 623-628.
- [27] Chitta Baral, Le-Chi Tuan, and Tran Cao Son. Golog+HTN<sup>TI</sup>: Adding time and intervals to procedural and hierarchical control knowledge. Proc. of the Sixth International Symposium on Logical Formalizations of Commonsense Reasoning, 2003 AAI Spring Symposia Series, Stanford, USA.
- [28] G. Gonzalez, C. Baral, and P. Cooper. Modeling Multimedia Displays Using Action Based Temporal Logic. In Proc. of VDB 2002, pages 141-155, 2002.
- [29] C. Baral, N. Tran and L. Tuan. Reasoning about actions in a probabilistic setting. In Proc. of AAI'2002, pages 507-512, 2002.
- [30] C. Baral, T. Son and L. Tuan. A transition function based characterization of actions with delayed and continuous effects. In Proc. of KR'02, pgs 291-302, 2002.

- [31] C. Baral and Y. Zhang. The Complexity of Model Checking for Knowledge Update. In Proc. of KR'02, pgs 82-93, 2002.
- [32] C. Baral, L. Tuan and T. Son. Using Smodels to reason about actions in presence of resources: applications to planning and scheduling. In Proc. of International Conference on Information Technology (CIT'01), pages 3-8, 2001.
- [33] C. Baral and C. Uyan. Declarative specification and solution of combinatorial auctions using logic programming. In Proc. of Int'l conference on Logic programming and non-monotonic reasoning (LPNMR01), pgs 186-199, 2001.
- [34] Tran Cao Son, Chitta Baral, Sheila McIlraith. Planning with domain-dependent knowledge of different kinds – an answer set programming approach In Proc. of Int'l conference on Logic programming and non-monotonic reasoning (LPNMR01), pgs 226-239, 2001.
- [35] C. Baral, V. Kreinovich and R. Trejo. Computational Complexity of Planning with Temporal Goals. In Proc. of IJCAI 2001, pgs 509-514, 2001.
- [36] C. Baral and Y. Zhang. On the Semantics of Knowledge Update. In Proc. of IJCAI 2001, pgs 97-102, 2001.
- [37] C. Baral and L. Tuan. Reasoning about actions in a probabilistic setting. In Proceedings of commonsense 2001.
- [38] L. Tuan and C. Baral. Effect of knowledge representation on model based planning : experiments using logic programming encodings. In *Proceedings of AAAI Spring symposium on Answer Set Programming: Towards Efficient and Scalable Knowledge Representation and Reasoning 2001*, pages 110-115.
- [39] T. Son, C. Baral and S. McIlraith. Extending Answer Set Planning with Sequence, Conditional, Loop, Non-Deterministic Choice, and Procedure Constructs. In *Proceedings of AAAI Spring symposium on Answer Set Programming: Towards Efficient and Scalable Knowledge Representation and Reasoning 2001*, pages 202-209.
- [40] Goce Trajcevski, Chitta Baral and Jorge Lobo. Formalizing (and Reasoning About) the Specifications of Workflows. In *Proceedings of the Fifth IFCIS International conference on Cooperative Information Systems (CoopIS'2000)*. (Awarded one of the best paper award.)
- [41] C. Baral, L. Tuan, R. Trejo and V. Kreinovich. Computational Complexity of Planning Based on Partial Information About The System's Present and Past States. In *Proc. of First International Conference on Computational Logic (KR track) CL'2000*, pages 882-896.
- [42] M. Nakamura and C. Baral. Invariance, Maintenance and other declarative objectives of triggers – a formal characterization of active databases. In *Proc. of First International Conference on Computational Logic (DOOD track) CL'2000*, pages 1210-1224.
- [43] M. Nakamura, C. Baral and M. Bjärelund. Maintainability: a weaker stabilizability like notion for high level control. In *AAAI 2000*, pages 62-67.
- [44] R. Trejo, V. Kreinovich and C. Baral. Towards Feasible Approach to Plan Checking Under Probabilistic Uncertainty: Interval Methods. In *AAAI 2000*, pages 545-550.

- [45] C. Baral, S. McIlraith, and T. Son. Formulating diagnostic problem solving using an action language with narratives and sensing. In *Proceedings of KR 2000*, pages 311-322, Morgan Kaufmann.
- [46] C. Baral and T. Son. Extending ConGolog to allow partial ordering. In *Intelligent Agents VI – Agent Theories Architectures and Languages (Proc. of ATAL-99)*, ed. N. Jennings and Y. Lesperance, Springer, pages 188-204. (*Best paper award.*)
- [47] C. Baral and G. Gonzalez. Specifying Generic Multimedia 3D Visualizations and Temporal Presentations from Database Queries. In proceedings of IEEE ICMCS' 99 (IEEE International Conference on Multimedia Computing and Systems), vol 1, pages 550-555.
- [48] C. Baral, V. Kreinovich and R. Trejo. Planning and Approximate Planning in presence of incompleteness. In proceedings of *IJCAI 99*, pages 948-953.
- [49] C. Baral and T. Son. Formalizing sensing actions – a transition function based approach. In proceedings of *AAAI 98 Fall Symposium on Cognitive Robotics*, October 98.
- [50] C. Baral, G. Gonzalez and A. Nandigam. SQL+D:extended display capabilities for multimedia database queries. In proceedings of *6th ACM Multi-media conference*, September 98, 109-114.
- [51] C. Baral, L. Floriano, A. Hardesty, D. Morales, M. Nogueira and T. Son. From theory to practice: The UTEP robot in AAAI 96 and AAAI 97 robot contests. In *proceedings of the second international conference on autonomous agents (Agents 98)*, 32-38.
- [52] C. Baral, G. Gonzalez and T. Son. Design and Implementation of Display Specification for Multi-media Answers. In proceedings of 1998 International Conference on Data Engineering (ICDE 98), 558-565.
- [53] C. Baral and J. Lobo. Formal Characterizations of Active Databases: Part II In proceedings of *International Conference on Deductive and Object-oriented database systems (DOOD) 1997*, pgs 247-264 (LNCS 1341).
- [54] C. Baral and J. Lobo. Formalizing workflows as cooperative agents In proceedings of ILPS 97 (International logic programming symposium) workshop on (Trans)Actions and Change in Logic Programming and Deductive Databases (DYNAMICS 97).
- [55] C. Baral and T. Son. Approximate reasoning about actions in presence of sensing and incomplete information. In *proceedings of International Logic Programming Symposium (ILPS) 97*, pages 387-401.
- [56] C. Baral and J. Lobo. Defeasible Specifications in Action Theories. In proceedings of *IJCAI 1997*, 1441-1446, 1997.
- [57] C. Baral and T. Son. Regular and special sensing in robot control - relation with action theories. In proceedings of the *AAAI 97 Workshop on Robots, Softbots, and immobots - Theories of Action, Planning and Control*.
- [58] C. Baral, T. Son, and G. Gonzalez. Issues in querying multi-media databases. In proceedings of 2nd international workshop on multimedia information systems, 1996.
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- [60] C. Baral, A. Gabaldon and A. Proveti. Value minimization in Circumscription. In KR 96, pages 474-481.
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- [62] C. Baral, L. Floriano, A. Gabaldon, D. Morales, T. Son and R. Watson. A reactive mobile robot based on a formal theory of action. In proceedings of AAAI 96 as a robot competition abstract, page 1350. *Our entry was placed third in the competition.*
- [63] C. Baral, A. Gabaldon and A. Proveti. Formalizing Narratives using Nested Circumscription. In proceedings of AAAI 96, Aug 4-8, Portland, OR, USA, pages 652-657.
- [64] G. Mendez, J. Lobo, J. Llopis, and C. Baral. Temporal logic and reasoning about actions. Presented in Common-sense 96.
- [65] C. Baral, A. Gabaldon and A. Proveti. Formalizing Narratives using Nested Abnormality Theories. Presented in Common-sense 96.
- [66] C. Baral. A systematic approach to reason about actions, planning and Robot Control. Proceedings of 33rd Annual Allerton Conference on Communication, Control and Computing, October 4-6, 1995. (Invited non-refereed paper)
- [67] C. Baral and Michael Gelfond. Reasoning about actual and hypothetical occurrences of concurrent and non-deterministic actions. In IJCAI 1995 Workshop on Nonmonotonic reasoning, action and change, August 19-25, Montreal, Canada.
- [68] C. Baral. Reasoning about actions: Non-deterministic effects, Constraints, and Qualification. In proceedings of IJCAI 1995, 2017-2023, August 1995.
- [69] C. Baral, M. Gelfond and A. Proveti. Representing Actions-I: (Laws, Observation and Hypothesis) In Proceedings of AAAI 1995 Spring Symposium, March 27-29.
- [70] C. Baral. Rule based updates on simple knowledge bases. In *Proc. of AAAI 94*, 136-141, 1994.
- [71] C. Baral, M. Gelfond and O. Kosheleva. Approximating general logic programs. In *Proceedings of International Symposium in Logic Programming 93*, Vancouver, BC, pages 181-198, November 1993.
- [72] C. Baral and Michael Gelfond. Representing Concurrent actions in Extended Logic Programs. In *Proceedings of IJCAI 93*, pages 866-873, August 1993.
- [73] C. Baral.  $L_3$ : A logic programming language with multiple default negations. In *Proc. of Fifth International Symposium on AI*. Cancun, Mexico, December 1992.
- [74] C. Baral. Generalized Negation As Failure and Semantics of Normal Disjunctive Logic Programs. In the *Proceedings of International Conference on Logic Programming and Automated Reasoning*, St. Petersburg, 1992. In *Lecture notes in AI- 624*, edited by A. Voronkov, pages 309-319.
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- [76] C. Baral, S. Kraus, J. Minker and V. S. Subrahmanian. Combining Knowledge Bases Consisting of First Order Theories. In the *Proceedings of Sixth International Symposium on Methodologies for Intelligent Systems*, Charlotte, NC, 1991. In *Lecture Notes in Artificial Intelligence*. No 542. Z.W. Ras and M. Zemankova, Eds. Springer-Verlag. Charlotte, N.C. Oct (1991). 92-101.
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- [78] C. Baral, S. Kraus, J. Minker and V. S. Subrahmanian. Combining and Updating Knowledge Bases Consisting of Default Theories. In the proceedings of *Bar-Ilan Symposium on the Foundations of Artificial Intelligence*, Israel, 1991.
- [79] C. Baral and V. S. Subrahmanian. Duality between Alternative Semantics of Logic Programs and Nonmonotonic Formalisms. In the proceedings of *International Workshop on Logic Programming and Nonmonotonic Reasoning*, Washington DC, 1991, ed. Nerode, Marek and Subrahmanian, MIT press, pages 69-86.
- [80] C. Baral and V. S. Subrahmanian. Stable and Extension Class Theory for Logic Programs and Default Logics. Presented in the *Third International Workshop on Non-monotonic Reasoning*, South Lake Tahoe, California, May 31, 1990.
- [81] C. Baral, J. Lobo and J. Minker. Generalized disjunctive well-founded semantics for logic programs: Declarative semantics. In M. Zemankova, Z. W. Ras and M. L. Emrich, editors, *Proc. of Fifth International Symposium on Methodologies for Intelligent Systems*, pages 465-473, Knoxville, TN, 1990. North-Holland.
- [82] C. Baral, J. Lobo and J. Minker. Generalized disjunctive well-founded semantics for logic programs: Procedural semantics. In M. Zemankova, Z. W. Ras and M. L. Emrich, editors, *Proc. of Fifth International Symposium on Methodologies for Intelligent Systems*, pages 456-464, Knoxville, TN, 1990. North-Holland.
- [83] C. Baral, J. Lobo and J. Minker. Generalized Well-Founded Semantics for Logic Programs. In M. E. Stickel, editor, *Proc. of Tenth International Conference on Automated Deduction*, pages 102-116, Kaiserslautern, FRG, July, 1990. Springer-Verlag.
- [84] C. Baral, S. Kraus and J. Minker. Communicating between Multiple Knowledge Based Systems. Presented in the *International Working Conference on Cooperating Knowledge Based Systems*, University of Keele, England, October 1990.
- [85] A. Roy, V. Haldar and C. Baral. Identification of Geometric Features from Hierarchical Coding of Images. Presented in the *Second International Conference on Advances in Pattern Recognition and Digital Techniques*, Calcutta, India, Jan 6-9, 1986.

## Courses Taught

- Taught undergraduate courses on Artificial Intelligence (Fall 91), Automata and Languages (Fall 91 and Fall 92), Computer Architecture (Fall 92, Fall 93, Fall 94, Fall 95, Fall 96), Operating Systems (Spring 92, Spring 93, Spring 94, Spring 95), Database Systems (Fall 97, Fall 98,

Spring 01), Design and analysis of Algorithms (Spring 00), Building and Programming Mobile Robots (Spring 96, Spring 97, Spring 98, Spring 99, Fall 00), and Introduction to theoretical Computer Science (Spring 02, Fall 02, Spring 04).

- Taught graduate courses on Database Theory (Spring 92, Spring 93, Spring 94, Spring 95, Spring 96, Spring 97, Spring 98), Object Oriented and Distributed Databases (Fall 93, Fall 94), Cognitive Robotics (Fall 95), Knowledge Representation (Summer 92), Autonomous Agents (Fall 97, Fall 01, Fall 04), Web authoring and multi-media databases (Fall 96), Multimedia Systems (Fall 98), Artificial Intelligence (Fall 99, Spring 01, Fall 03), Computational Molecular Biology (Spring 03), and Application of AI to molecular biology (Fall 2003).

## Honors

- Invited Speaker AAAI'05.
- Awarded one of the best paper award at the Fifth IFCIS International conference on Cooperative Information Systems (CoopIS'2000) for the paper 'Formalizing (and Reasoning About) the Specifications of Workflows' with Jorge Lobo and Goce Trajcevski.
- Best paper award at the ATAL 99 (Agent theories, architectures and languages) for the paper 'Extending Congolog with partial order' with Tran Son.
- Team advisor of the robot team entry from UTEP that won the first place in the 'Home vacuuming' part of the AAAI 97 robot contest.
- Team advisor of the robot team entry from UTEP that won the third place in 'Office Navigation' part of the AAAI 96 robot contest.
- Invited Speaker at the 33rd Annual Allerton Conference on Communication, Control and Computing, October 4-6, 1995.
- Received the NSF RIA (1992) and CAREER (1995) awards.
- Received a Graduate Research Fellowship (1990) award from the graduate school of University of Maryland, College Park, MD 20742.
- Awarded the J. N. Tata scholarship (1987) for higher studies.
- Awarded the R. D. Sethna scholarship (1987) for higher studies.
- Received the "Best B. Tech thesis" award in Computer Science and Engineering in 1987 at the Indian Institute of Technology, Kharagpur, India, for the thesis titled : "Natural Language Interface for a Relational Database" (co-author A. Patel).
- Won the joint first prize in undergraduate IEEE student paper writing contest (1985) for the papers

- C. Baral and A. G. Ray. An Efficient Recursive Algorithm for Constructing Quadrees.
- C. Baral. Alternative efficient structures for linear quadrees and Octrees.

## Grants and Contracts

- PI, Research in Knowledge Representation and Common Sense Reasoning.  
NSF RIA (Research Initiation Award) grant IRI-9211662 of \$89,956 for the period 7/92 to 12/95.
- PI, A Systematic Approach to Reasoning about Actions and Change.  
NSF CAREER award (IRI-9501577) of \$135,000 for the period 9/95 to 9/99.
- Co-PI (till Aug 98), PI (Aug 98 - May 99), The University of Texas at El Paso Network Resources and Training Site.  
NASA, \$2,499,822 for 9/1/1995 - 8/31/2000.
- PI, Implementation of spatial data management at Ft. Bliss – support for student S. Sahu.  
US Army Constr Engg Research, Ltd \$4,273 for 6/01/96-8/31/96.
- PI, An undergraduate laboratory for building and programming intelligent mobile robots.  
NSF ILI award of \$40,000 for the period of 7/1/97 - 6/30/99.  
As required by the NSF ILI program UTEP matches the award by another \$40,000.
- Co-PI, AI technologies for space applications.  
United Space Alliance, Houston, \$57,660 for the period 6/1/97 to 8/31/98.
- PI, A Systematic approach to reasoning about actions – Transfer to ASU. NSF. \$62,027 for the period of 8/31/99 - 8/31/00.
- PI, Reasoning and planning with sensing actions and their applications. NSF. \$331,714 for the period of 4/1/2000 - 3/31/2005.
- PI, Agent development and control verification using dual characterizations. NASA. \$175,000 for the period of 3/1/2001 – 3/31/2004.
- PI, Answering complex questions and performing deep reasoning in advance question answering systems, AQUAINT program, ARDA, \$808,019 for the period of 5/3/04-10/31/06. (includes external sub-contract of \$469,007; hence ASU portion is \$339,012.)
- PI, Knowledge representation, reasoning, and problem solving in a cellular domain, NSF, \$399,000 for the period of 8/1/04-7/31/07.

## Student mentoring and advising

### Doctoral Students<sup>2</sup>

*Tran Son* graduated in Spring 2000. Assistant Professor at the New Mexico state University and Visiting Scientist at the Knowledge Systems Laboratory, Stanford University. (Best doctoral dissertation of the University of Texas at El Paso award, 2000.)

*Graciela Gonzalez* graduated in Fall 2000. Assistant Professor at the Sam Houston State University. (Starting August 2001.)

*Raul Trejo* graduated in Spring, 2001. (Was also co-advised by Vladik Kreinovich of UT El Paso.) Assistant Professor, ITESM, Mexico City. (Best doctoral dissertation of the University of Texas at El Paso award, 2001.)

*Le-Chi Tuan* graduated in December 2004.

*Nam Tran* started (at ASU) in Spring 2001.

*Xin Zhang* started (at ASU) in Spring 2003.

*Luis Tari* started (at ASU) in Fall 2003.

*Saadat Anwar* started (at ASU) in Fall 2003.

*Jicheng Zhao* started (at ASU) in Fall 2003.

### Masters Students

Advised thesis/project of 19 students (A. Gabaldon<sup>3</sup>, Y. Gelfond, S. Hota, D. Bhattacharya, R. Vijayrangam, G. Gonzalez, P. Madden, D. Morales, A. Nandigam, B. Ayuluri, B. Rachamreddy, S. Sahu, M. Hampton, D. Schirmer, and A. Hardesty at UTEP, and S. Culver, Luis Tari and Piyun Chang at ASU.)

Hiro Takahashi and Deepthi Chidambaram (co-advised by Hasan Davulcu) are currently working on their Masters thesis with me.

### Undergraduate Students

Alfredo Gabaldon and Patrick Kahl started working with me when they were undergraduates and went on to do their M.S.

At one time 4 undergraduate students and one high school student were working with me in my mobile robots lab at UTEP.

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<sup>2</sup>These three students are the 2nd, 3rd and 4th student to obtain a Ph.D from the computer science department at the University of Texas at El Paso. Currently, four students have graduated from this program and all of them are in academia as faculty. I had a major role to play in establishing this program at UT El Paso.

<sup>3</sup>He is currently pursuing his Ph.D at the University of Toronto.

Guray Alsac worked with me as an undergraduate researcher and was supported by an NSF REU supplement. He is now pursuing a Ph.D at University of Massachusetts, Amherst.

### **External Students**

- Opponent of Joakim Gustafsson, Linkoping University, Sweden.
- Examiner for Mikhail Prokopenko, Macquarie University NSW 2109, Australia.
- External Ph.D committee member of Esra Erdem, University of Texas at Austin.
- External Ph.D committee member of Yuting Zhao, Hong Kong University of Science and Technology.
- External Ph.D committee member of Rajdeep Niyogi, Indian Institute of Technology, Kharagpur, India.
- External Ph.D committee member of Marcello Balduccini, Texas Tech University.

### **Professional Activities**

- Area Editor (Knowledge representation, non-monotonic reasoning and answer sets), ACM Transactions on Computational Logic.
- Editorial Advisor (4/15/2005 – 12/31/2007) of the journal “Theory and Practice of Logic Programming”.
- Program committee member of AAAI 2005.
- Steering committee member of International Workshops on Nonmonotonic Reasoning. (<http://www.kr.org/nm/>)
- Co-Program Chair, LPNMR’05.
- General Chair, CIT’04.
- Senior program committee of AAAI 2004.
- Program committee member of IJCAI 2003.
- Co-Editor, Special issue of *Theory and practice of Logic Programming* on answer set programming to appear in 2003.
- Co-Program Chair of CogRob’2002.
- Senior program committee of AAAI 2002.

- Organizing Committee, AAAI Spring symposium on Answer set programming, 2001.
- Co-Program Chair of NM'2000 (8th International Workshop on Non-monotonic reasoning).
- Program Chair of CIT 99 (Second International Conference on Information Technology).
- Organizing Committee, CogRob'2000 (2nd International Cognitive Robotics Workshop).
- Program Committee of AAAI 97, AAAI 98, AAAI 99, AAAI 2000, IJCAI'2003; AAAI 98 Fall Symposium on Cognitive robotics; CIT98; LPNMR 99; CLIMA-00 (Workshop on Computational Logic in Multi-agent systems).
- Overseas Secretary, Orissa Information Technology Society (<http://www.oits.org>) from 1998-2001.
- Co-Editor, Special issue of *Annals of Math and AI*, Vol. 21 (1997) Nos. 2-4.
- Co-Chair, AAAI 97 Workshop on “ROBOTS, SOFTBOTS, IMMOBOTS: Theories of Action, Planning and Control”.
- Chair, AAAI 96 Workshop on “Reasoning about actions, planning algorithms and control architectures : Bridging the gap.”
- Member of program committee and main organizer of Workshop on *Logic Programming with Incomplete Information*, held together with 1993 International Symposium on Logic Programming, Vancouver, BC, Canada.
- Member, Program Committee of the *ICLP'95 Workshop on Abduction in Deductive Databases and Knowledge-based Systems* Kanagawa, Japan.
- Panelist, 1995 Spring Symposium on Extending theories of actions.
- Refereed articles for AI Journal, Journal of AI Research, Journal of Automated Reasoning, Journal of Logic Programming, Journal of Logic and Computation, Annals of Math and AI, Journal of Experimental and Theoretical AI, Journal of Intelligent Information Systems, ACM transactions on Database Systems, IEEE Transactions on Knowledge and Data Engineering, and various conferences on Databases, Artificial Intelligence, Logic Programming and Knowledge Representation.
- Refereed articles for conferences such as: ICLP90, VLDB90, NACL90, DOOD91, AAAI93, IJCAI93, ICLP93, LPNMR93, ILPS94, ISMIS94, ICLP95 and LPNMR95.

## Invited Lectures

- “Semantics of Nonmonotonic Formalisms”, Department of Computer Science, New Mexico State University, Las Cruces, USA (Dec 1991).

- “A language for reasoning about actions and change”, Department of Law and Philosophy, University of Bologna, Italy (Jan 1994).
- “Abductive Logic Programming”, Department of Computer Science, University of Modena, Italy (Jan 1994).
- “Logical Basis of Disjunctive Databases”, Department of Computer Science, University of Milan, Italy (Jan 1994).
- “Knowledge Representation in Artificial Intelligence”, Xaviers School of Business Management, Bhubaneswar, India (Jan 1994).
- “Rule Based Updates in Simple Knowledge Bases”, Department of Computer Science, University of Nebraska, Lincoln, USA (April 1994).
- “Reasoning about Situations”, Department of Computer Science, University of Texas at Austin, USA (August 1994).
- “Reasoning about Actions and Change”, Department of Electrical Engineering and Computer Science, University of Illinois at Chicago, USA (October 20, 1994).
- “A systematic approach to reason about actions, planning and Robot Control”. Invited Speaker at the 33rd Annual Allerton Conference on Communication, Control and Computing, October 4-6, 1995.
- “Reasoning about actions and its relation to robot control and database updates”, Department of Computer Science, University of Corona, La Cornua, Spain (June 1996).
- “Reasoning about actions and its relation to robot control and database updates”, Department of Computer Science, Griffith University, Brisbane, Australia (Jan 17, 1997).
- “From action theories to agents – a formal approach to agents”, Seminar at IRST, Trento, Italy, Aug 18, 1997.
- “From action theories to agents – a formal approach to agents”, Invited Lecture at the Symposium on logical approaches to agent modeling and design, held as part of the ESSLLI’97 (Ninth European Summer School in Logic, Language and Information), Aix-en-Provence, France, August 20, 1997.
- “From action theories to agents – a formal approach to agents”, TRAIL seminar at Imperial College, London, Aug 26, 1997.
- “From action theories to agents”, University of Toronto, Feb 6, 1998.
- “Representing actions: Laws, Observations and Hypothesis”, York University, Toronto, Feb 7, 1998.
- “From action theories to agents”, Linkoping University, Sweden, Sept 18, 1998.

- “Knowledge representation, reasoning and declarative problem solving”, International Conference on Information Technology, Bhubaneswar, Dec 22nd, 2000.
- Invited to speak at the Joint German/Austrian Conference on Artificial Intelligence (KI-2001), Vienna, Sept 2001. (Could not go because of the September 11 incident.)
- Knowledge representation, reasoning and declarative problem solving with answer sets. Dagstuhl seminar. Germany Sept’02.
- Several talks at the Vienna U of Technology Vienna May’03.
- From high-level goals to policies: a polynomial time algorithm for k-maintainable goals. NASA JPL. Jan’04.
- From high-level goals to policies: a polynomial time algorithm for k-maintainable goals. University of Texas at Austin. Feb’04.

## **Tutorials and Short Courses**

- “From Actions Theories to Updates, Transactions, Triggers and Agents”, A joint tutorial at DOOD 97 (Montreux, Switzerland) with J. Lobo, Dec 10, 1997.
- “From action theories to agents – planning control strategies for reactive agents”, A joint tutorial at AAAI 98 (Madison, Wisconsin) with F. Kabanza. (65 registered participants)
- “A logical approach to building agents, active databases and workflows: representing and reasoning about actions”, A two week course to be given at ESSLLI 99 (11th summer school in logic, language and information) with Jorge Lobo and Richard Scherl. (35 registered participants)
- A short course at the Vienna U of Technology, Vienna May’03. 184.186 - 2.0 VU Theorie der Wissensrepresentation (Theory of Knowledge Representation)

## **Service and outreach activities – highlights**

- Recruiting Committee Chair, Dept of CSE, Arizona State University, Fall 2004 - Spring 2005.
- Executive Committee, Dept of CSE, Arizona State University, Fall 2004.
- Personnel Committee, Dept of CSE, Arizona State University, 2000- 2001; 2002- Spring 2005 (Chair during Fall 2003)
- CEAS Senate representative, member of graduate admission committee, member of TA and financial aid committee, 2001-2004.
- Faculty mentor for one summer intern at Intel as part of the Embedded Systems Initiative.

- Chair of the graduate admissions committee, and member of graduate program committee, Dept of CSE, Arizona State University, August 1999 – May 2001.

(During this tenure the graduate admissions committee received and processed more than 2500 applications. I organized an information session for ASU seniors to encourage them to pursue graduate studies at ASU and other universities. I also actively participated in making certain changes to the graduate admissions requirement so as to make it more attractive to top notch students.)

- Graduate Advisor and in charge of the graduate program in Computer Science at UTEP from Fall 94 till Spring 99.
- Instrumental in having a Ph.D program for Computer science students at UTEP.
- Developed – through students – the first Web pages for the university and the local area (the city of El Paso and Juarez), in 1993 and wrote op-ed articles in the El Paso Times newspaper to increase local awareness about the WWW.
- Held several robot building workshops and robot demonstrations for El Paso area school teachers and students.
- Have been featured (together with my students) many times in the El Paso newspapers, TV stations, and the university alumni magazine.