

Siddharth Patwardhan

Cupertino, CA

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HIGHLIGHTS

- ✓ More than sixteen years of (academic and industrial) experience in Natural Language Processing research
 - ✓ Over 30, highly cited, scientific publications on various topics in Language Technologies
 - ✓ Member of program committees of top NLP conferences and reviewer for leading scientific journals in AI
 - ✓ ML and NLP Researcher on Apple's team creating Siri for international locales
 - ✓ Research scientist on the team that created IBM Watson – human-vs-machine Jeopardy! Q&A system
 - ✓ NCERT (India) National Talent Search scholar
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EDUCATION

University of Utah, Salt Lake City, UT

PhD, Computer Science

May 2010

University of Minnesota, Duluth, MN

MS, Computer Science

Aug 2003

University of Pune, India

BE, Computer Engineering

May 2001

EMPLOYMENT HISTORY

NLP and Machine Learning Scientist

Apple, Cupertino, CA

Sep 2016 – present

Research Staff Member

IBM Watson Group, Yorktown Heights, NY

Oct 2014 – Aug 2016

Senior Software Engineer

IBM T. J. Watson Research Center, Yorktown Heights, NY

Feb 2012 – Oct 2014

Post Doctoral Researcher

IBM T. J. Watson Research Center, Hawthorne, NY

Oct 2009 – Feb 2012

Research Assistant

School of Computing, University of Utah, Salt Lake City, UT

Aug 2003 – Oct 2009

Summer Research Intern

IBM T. J. Watson Research Center, Hawthorne, NY

May 2007 – Aug 2007

Summer Research Intern

Division of Biomedical Informatics, Mayo Clinic, Rochester, MN

May 2003 – Aug 2003

Teaching Assistant

Department of Computer Science, University of Minnesota, Duluth, MN

Aug 2001 – May 2003

PROJECTS

Siri International: Investigate and contribute to the development of machine learning and natural language technologies that power Apple's Siri intelligent assistant for international locales. **2016-now**

Watson for Healthcare: Lead the research and development of question answering technology and NLP technology applied to electronic health records. [publication in ACL '16, and as an AMIA-CRI '16 podium abstract] **2011-2016**

WatsonPaths: Designed and developed language technologies for the adaptation of IBM Watson system to automatically answer “scenario-based” questions (in the medical domain), through inference over unstructured data. [publications in AI Magazine '17, IBM Research Report] **2011-2014**

IBM Jeopardy! Challenge: Conducted research and development for the creation of IBM's Watson question answering system that defeated humans in a widely-televised demonstration of human vs. machines challenge on the *Jeopardy!* game show. [publications in Journal of Natural Language Engineering, IBM Journal of R&D, CIKM '12, EMNLP '11, CIKM '11] **2009-2011**

Machine Reading Project: Investigated and developed information extraction components used within a DARPA-funded project on combining information extraction and reasoning to read, understand and answer queries about text documents. [publications at EACL '12 and COLING '10] **2009-2011**

GLACIER Information Extraction System: Created a probabilistic model for event extraction from text, using sentence-based event recognizers and contextual evidence detectors, to extract role fillers of event descriptions in text. [publication at EMNLP '09] **2009**

PIPER Information Extraction System: Lead the design and implementation of a two-phase system for extracting event information from text by combining global relevance cues with local contextual evidence. [publication at EMNLP-CoNLL '07] **2007**

Learning IE Patterns from the Web: Created a system for improving the coverage of textual Information Extraction by learning new extraction patterns from the Web texts. [publication at an ACL '06 workshop] **2006**

Subsumption Hierarchy for Opinion Analysis: Implemented a hierarchical structure and code for selecting the best combination of lexical and syntactic features in a system for detecting opinions in text. [publication at EMNLP '06] **2006**

Opinion Source Identification: Developed a system for identifying the holders of opinions in free text using lexico-syntactic features in a sequence labeling machine learning system. [OpinionFinder, system demo at EMNLP '05] **2005**

Generative Model for Role Labeling: Contributed to a machine-learning system (trained using FrameNet) for automatically assigning semantic roles to words in text. [participant in SENSEVAL-3 evaluation] **2004**

WordNet::SenseRelate: A system that determines the intended meaning of a word from its context using the notion of Semantic Relatedness of concepts. [system demo at ACL '05 and AAAI '05] **2004**

Semantic Similarity of Biomedical Concepts: An adaptation of existing Computational Linguistics research to the biomedical domain, for measuring the semantic similarity of biomedical terms and concepts. [article in Journal of Biomedical Informatics] **2003**

WordNet::Similarity: Lead the design and implementation of several algorithms for automatically measuring the semantic similarity and relatedness of English words and concepts. [system demo at NAACL '04 and AAAI '04] **2003**

PROFESSIONAL SERVICE AND AWARDS

Outstanding Technical Contribution Award, IBM Watson Group (2014)

AAAI Feigenbaum Prize (to the Watson team), the Association for Advancement of Artificial Intelligence (2013)

Area Chair (Information Retrieval and Question Answering), COLING '14

Senior Program Committee Member, IJCAI '16

Publications Chair, EMNLP '17, EMNLP '16

Advisory Board, DropThought Inc. (2011 – 2016)

Program Committee, ACL '18, NAACL '18, COLING '18, IJCAI-ECAI '18, ACL '17, EACL '17, AAAI '17, COLING '16, IJCAI '16, NAACL '16, ACL '16, AMIA CRI '16, *SEM '16, EMNLP '15, ACL-IJCNLP '15, NAACL '15, *SEM '15, EMNLP '14, ACL '14, EACL '14, LREC '14, SIGIR '14 Workshop on Semantic Matching in Information Retrieval, IJCNLP '13, ACL '13, NAACL-HLT '13, COLING '12, EMNLP-CoNLL '12, ACL '12, NAACL-HLT '12, RANLP '11 Workshop on Information Extraction and Knowledge Acquisition, EMNLP '11, ACL-HLT '11, EMNLP '10, COLING '10, NAACL-HLT '10, ACL '08

Reviewer, Transactions of the Association for Computational Linguistics ('18, '17, '16, '15, '14, '13), IEEE Transactions on Audio, Speech and Language Processing ('17, '16), Artificial Intelligence ('15), Natural Language Engineering ('15, '13), Language Resources and Evaluation ('12), Data Mining and Knowledge Discovery ('11), Journal of Artificial Intelligence Research ('09), NESCAI ('08, '07)

Auxiliary Reviewer, AAAI '16, CIKM '14, AAAI '06.

Session Chair, CIKM '12, ACL '06 Workshop on *Information Extraction Beyond the Document*

Graduate Student Advisory Committee, School of Computing, University of Utah (2004)

Most Outstanding Teaching Assistant, University of Minnesota Duluth, MN (2003)

National Talent Search Scholarship, National Council for Educational Research & Training, India (1995 – 2001)

PATENTS

- D. Ferrucci, D. Gondek, A. Kalyanpur, A. Lally, and S. Patwardhan. **Fact Checking Using and Aiding Probabilistic Question Answering**. *US Patent 8,959,043 B2*. February 2015.
- B. Boguraev, J. Chu-Carroll, A. Kalyanpur, D. McClosky, J. W. Murdock and S. Patwardhan. **Entailment Knowledge Base in Natural Language Processing Systems**. *US Patent Application 14/986,759*, filed January 2016. Patent Pending.
- M. Devarakonda, S. Patwardhan and P. Raghavan. **Automated Timeline Completion Using Event Progression Knowledge Base**. *US Patent Application 15/172,813*, filed June 2016. Patent Pending.
- B. Boguraev, E. Khorasani, V. Sheinin, S. Patwardhan and P. Zerfos. **Natural Language Interface to Databases**. *US Patent Application 14/858,841*, and *WO Patent Application PCT/IB2016/055494*, filed September 2015. Patent Pending.
- B. Boguraev, E. Khorasani, V. Sheinin, S. Patwardhan and P. Zerfos. **Robust and Readily Domain-Adaptable Natural Language Interface to Databases**. *US Patent Application 14/858,912*, filed September 2015. Patent Pending.
- S. Berajawala, A. Levas, S. Patwardhan, and D. Taieb. **Collaborative Creation of Annotated Training Data**. *US Patent Application 14/553,028*, filed November 2014. Patent Pending.
- B. Boguraev, D. Buchanan, J. Chu-Carroll, D. Ferrucci, A. Kalyanpur, J. W. Murdock, and S. Patwardhan. **Generating Secondary Questions in an Introspective Question Answering System**. *US Patent Application 13/610,267*, filed September 2012. Patent Pending.
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JOURNAL ARTICLES

- A. Lally, S. Bagchi, M. Barborak, D. Buchanan, J. Chu-Carroll, D. Ferrucci, M. Glass, A. Kalyanpur, E. Mueller, J. W. Murdock, S. Patwardhan, and J. Prager. **WatsonPaths: Scenario-based Question Answering and Inference over Unstructured Information**. *AI Magazine*, 38(2):59-76, Summer 2017.
- B. Boguraev, S. Patwardhan, A. Kalyanpur, J. Chu-Carroll, and A. Lally. **Parallel and Nested Decomposition for Factoid Questions**. *Natural Language Engineering*, 20(04):441-468, October 2014.
- A. Kalyanpur, S. Patwardhan, B. Boguraev, A. Lally, and J. Chu-Carroll. **Fact-based Question Decomposition in DeepQA**. *IBM Journal of Research and Development*, 56(3/4):13:1-13:11, May/July 2012.
- A. Kalyanpur, B. Boguraev, S. Patwardhan, J. W. Murdock, A. Lally, C. Welty, J. Prager, B. Coppola, A. Fokoue-Nkoutche, L. Zhang, Y. Pan, and Z. Qiu. **Structured Data and Inference in DeepQA**. *IBM Journal of Research and Development*, 56(3/4):10:1-10:14, May/July 2012.

- A. Lally, J. Prager, M. McCord, B. Boguraev, S. Patwardhan, J. Fan, P. Fodor, and J. Chu-Carroll. **Question Analysis: How Watson Reads a Clue.** *IBM Journal of Research and Development*, 56(3/4):2:1-2:14, May/July 2012.
- T. Pedersen, S. Pakhomov, S. Patwardhan, and C. Chute. **Measures of Semantic Similarity and Relatedness in the Biomedical Domain.** *Journal of Biomedical Informatics*, 40(3):288-299, June 2007.
- T. Kwon, N. Dhruv, S. Patwardhan, and E. Kwon. **Common Data Format Archiving of Large-Scale Intelligent Transportation Systems Data for Efficient Storage, Retrieval, and Portability.** *Journal of the Transportation Research Board: Transportation Research Record 1836*, pages 111-117, 2003.

REFEREED CONFERENCE PAPERS

- C. Shivade, P. Raghavan, and S. Patwardhan. **Addressing Limited Data for Textual Entailment across Domains.** In *Proceedings of the 54th Annual Meeting of the Association for Computational Linguistics*, Berlin, Germany, August 2016. [acceptance rate 28%]
- O. Melamud, D. McClosky, S. Patwardhan, and M. Bansal. **The Role of Context Types and Dimensionality in Learning Word Embeddings.** In *Proceedings of the 2016 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technology*, San Diego, CA, June 2016. [acceptance rate 25%]
- A. Moschitti, S. Patwardhan, and C. Welty. **Long-Distance Time-Event Relation Extraction.** In *Proceedings of the Sixth International Joint Conference on Natural Language Processing*, pages 1330-1338, Nagoya, Japan, October 2013. [acceptance rate 23%]
- S. Patwardhan, B. Boguraev, A. Agarwal, A. Moschitti, and J. Chu-Carroll. **Labeling by Landscaping: Classifying Tokens in Context by Pruning and Decorating Trees.** In *CIKM '12: Proceedings of the 21st ACM International Conference on Information and Knowledge Management*, Maui, HI, October 2012. [acceptance rate 13%]
- D. Hovy, J. Fan, A. Gliozzo, S. Patwardhan, and C. Welty. **When Did that Happen? - Linking Events and Relations to Timestamps.** In *Proceedings of the 13th Conference of the European Chapter of the Association for Computational Linguistics*, pages 185-193, Avignon, France, April 2012. [acceptance rate 27%]
- A. Kalyanpur, S. Patwardhan, B. Boguraev, A. Lally, and J. Chu-Carroll. **Fact-based Question Decomposition for Candidate Answer Re-ranking.** In *Proceedings of the 20th ACM Conference on Information and Knowledge Management*, Glasgow, UK, October 2011. [acceptance rate 35%]
- A. Moschitti, J. Chu-Carroll, S. Patwardhan, J. Fan, and G. Riccardi. **Using Syntactic and Semantic Structural Kernels for Classifying Definition Questions in Jeopardy!** In *Proceedings of the 2011 Conference on Empirical Methods in Natural Language Processing*, Edinburgh, UK, July 2011. [acceptance rate 23%]
- R. Kate, X. Luo, S. Patwardhan, M. Franz, R. Florian, R. Mooney, S. Roukos, and C. Welty. **Learning to Predict Readability using Diverse Linguistic Features.** In *Proceedings of the 23rd International Conference on Computational Linguistics*, Beijing, China, August 2010. [acceptance rate 22%]
- R. Bhagat, E. Hovy, and S. Patwardhan. **Acquiring Paraphrases from Text Corpora.** In *Proceedings of the Fifth International Conference on Knowledge Capture*, pages 161-168, Redondo Beach, CA, September 2009. [acceptance rate 26%]
- S. Patwardhan and E. Riloff. **A Unified Model of Phrasal and Sentential Evidence for Information Extraction.** In *Proceedings of the 2009 Conference on Empirical Methods in Natural Language Processing*, pages 151-160, Singapore, August 2009. [acceptance rate 34%]
- Y. Park, S. Patwardhan, K. Visweswariah, and S. Gates. **An Empirical Analysis of Word Error Rate and Keyword Error Rate.** In *Proceedings of the International Conference on Spoken Language Processing*, pages 2070-2073, Brisbane, Australia, September 2008. [acceptance rate 60%]
- S. Patwardhan and E. Riloff. **Effective Information Extraction with Semantic Affinity Patterns and Relevant Regions.** In *Proceedings of the 2007 Joint Conference on Empirical Methods in Natural Language Processing and Computational Natural Language Learning*, pages 717-727, Prague, Czech Republic, June 2007. [acceptance rate 27%]
- E. Riloff, S. Patwardhan, and J. Wiebe. **Feature Subsumption for Opinion Analysis.** In *Proceedings of the 2006 Conference on Empirical Methods in Natural Language Processing*, pages 440-448, Sydney, Australia, July 2006. [acceptance rate 31%]

- Y. Choi, C. Cardie, E. Riloff, and S. Patwardhan. **Identifying Sources of Opinions with Conditional Random Fields and Extraction Patterns.** In *Proceedings of Human Language Technology Conference and Conference on Empirical Methods in Natural Language Processing*, pages 355-362, Vancouver, Canada, October 2005. [acceptance rate 32%]
- S. Patwardhan, S. Banerjee, and T. Pedersen. **Using Measures of Semantic Relatedness for Word Sense Disambiguation.** In *Proceedings of the Fourth International Conference on Intelligent Text Processing and Computational Linguistics*, pages 241-257, Mexico City, Mexico, February 2003. [acceptance rate 46%]
- N. Dhruv, T. Kwon, and S. Patwardhan. **CDF Archival of Large-Scaled ITS Data for Efficient Archival, Retrieval, and Portability.** In *Proceedings of the Transportation Research Board 82nd Annual Meeting*, Washington, DC, January 2003.

REFEREED WORKSHOP PAPERS

- P. Raghavan and S. Patwardhan. **Question Answering on Electronic Medical Records.** In *Podium Abstract Presentations at AMIA 2016 Summit on Clinical Research Informatics*, San Francisco, CA, March 2016.
- A. Gliozzo, O. Biran, S. Patwardhan, and K. McKeown. **Semantic Technologies in IBM Watson.** In *Proceedings of the Fourth Workshop on Teaching NLP and CL*, pages 85-92, Sofia, Bulgaria, August 2013.
- S. Patwardhan. **Combining Global Relevance Information with Local Contextual Clues for Event-Oriented Information Extraction.** In *Proceedings of the Twenty-Third AAAI Conference on Artificial Intelligence (Doctoral Consortium)*, pages 1863-1864, Chicago, IL, July 2008.
- S. Patwardhan and E. Riloff. **Learning Domain-Specific Information Extraction Patterns from the Web.** In *Proceedings of the ACL 2006 Workshop on Information Extraction Beyond the Document*, pages 66-73, Sydney, Australia, July 2006.
- S. Patwardhan and T. Pedersen. **Using WordNet-based Context Vectors to Estimate the Semantic Relatedness of Concepts.** In *Proceedings of the EACL 2006 Workshop on Making Sense of Sense: Bringing Computational Linguistics and Psycholinguistics Together*, pages 1-8, Trento, Italy, April 2006.

SYSTEM DEMOS AND NON-REFEREED PAPERS

- C. Shivade, P. Raghavan and S. Patwardhan. **Addressing Limited Data for Textual Entailment Across Domains.** In *Preprint arXiv: 1606.02638*, June 2016.
- O. Melamud, D. McClosky, S. Patwardhan and M. Bansal. **The Role of Context Types and Dimensionality in Learning Word Embeddings.** In *Preprint arXiv: 1601.00893*, January 2016.
- S. Patwardhan, S. Banerjee and T. Pedersen. **UMND1: Unsupervised Word Sense Disambiguation Using Contextual Semantic Relatedness.** In *SemEval-2007: Proceedings of the 4th International Workshop on Semantic Evaluations*, pages 390-393, Prague, Czech Republic, June 2007.
- T. Wilson, P. Hoffmann, S. Somasundaran, J. Kessler, J. Wiebe, Y. Choi, C. Cardie, E. Riloff, and S. Patwardhan. **OpinionFinder: A System for Subjectivity Analysis.** In *Proceedings of HLT/EMNLP 2005 Interactive Demonstrations*, pages 34-35, Vancouver, Canada, October 2005.
- S. Patwardhan, T. Pedersen, and S. Banerjee. **SenseRelate::TargetWord - A Generalized Framework for Word Sense Disambiguation.** In *Proceedings of the Twentieth National Conference on Artificial Intelligence (Intelligent Systems Demonstrations)*, pages 1692-1693, Pittsburgh, PA, July 2005.
- S. Patwardhan, T. Pedersen, and S. Banerjee. **SenseRelate::TargetWord - A Generalized Framework for Word Sense Disambiguation.** In *Proceedings of the ACL Interactive Poster and Demonstration Sessions*, pages 73-76, Ann Arbor, MI, June 2005.
- C. Thompson, S. Patwardhan, and C. Arnold. **Generative Models for Semantic Role Labeling.** In *Proceedings of SENSEVAL-3: Third International Workshop on the Evaluation of Systems for the Semantic Analysis of Text*, pages 235-238, Barcelona, Spain, July 2004.
- T. Pedersen, S. Patwardhan, and J. Michelizzi. **WordNet::Similarity - Measuring the Relatedness of Concepts.** In *Proceedings of the Nineteenth National Conference on Artificial Intelligence (Intelligent Systems Demonstrations)*, pages 1024-1025, San Jose, CA, July 2004.

T. Pedersen, S. Patwardhan, and J. Michelizzi. **WordNet::Similarity - Measuring the Relatedness of Concepts.** In *Human Language Technology Conference of the North American Chapter of the Association for Computational Linguistics Demonstrations*, pages 38-41, Boston, MA, May 2004.

TECHNICAL REPORTS AND THESES

- A. Lally, S. Bagchi, M. Barborak, D. Buchanan, J. Chu-Carroll, D. Ferrucci, M. Glass, A. Kalyanpur, E. Mueller, J. W. Murdock, S. Patwardhan, J. Prager and C. Welty. **WatsonPaths: Scenario-based Question Answering and Inference over Unstructured Information.** Research Report RC25489 (WAT1409-048), IBM T. J. Watson Research Center, September 2014.
- S. Patwardhan. **Widening the Field of View of Information Extraction through Sentential Event Recognition.** PhD thesis, University of Utah, September 2009.
- T. Pedersen, S. Pakhomov, and S. Patwardhan. **Measures of Semantic Similarity and Relatedness in the Medical Domain.** Research Report DTC 2005/12, University of Minnesota Digital Technology Center, May 2005.
- T. Pedersen, S. Banerjee, and S. Patwardhan. **Maximizing Semantic Relatedness to Perform Word Sense Disambiguation.** Research Report UMSI 2005/25, University of Minnesota Supercomputing Institute, March 2005.
- S. Patwardhan. **Incorporating Dictionary and Corpus Information into a Context Vector Measure of Semantic Relatedness.** Master's thesis, University of Minnesota, Duluth, August 2003.

INVITED PRESENTATIONS

- Watson: From Jeopardy! to Medicine** Jul 2016
Invited Talk
IBM, Argentina
- Semantic Technologies for Automatic Question Answering** Jul 2016
Visiting Professor, ECI 2016 Winter School
University of Buenos Aires, Argentina
- Cognitive Computing: Question Answering Technologies Behind Watson** Mar 2015
Guest Instructor, IBM Online Course: <http://ibm.com/watsonacademy>
IBM, Armonk NY
- Case Study on IBM Watson** Nov 2015
Invited Guest Commentator, MBA Course: "Technology and Operations Management"
Harvard Business School, Boston MA
- UIMA in IBM Watson** Oct 2015
Guest Lecturer, Computer Science Course: "Semantic Technologies in IBM Watson"
Columbia University, New York NY
- Building Applications with Watson Experience Manager** Oct 2014
Guest Lecturer, Computer Science Course: "Natural Language Processing with Watson"
Rensselaer Polytechnic Institute, Troy NY
- Building IBM's Watson: Technical Insights into the Jeopardy-winning DeepQA Technology** Sept 2014
Invited Speaker, First Workshop on Cognitive Systems and Watson
National University of Singapore, Singapore
- Jeopardy! "Special" Questions: Exploring the Boundaries of Watson** March 2014
Guest Lecturer, Computer Science Course: "Natural Language Processing with Watson"
Rensselaer Polytechnic Institute, Troy NY
- Watson Beyond Jeopardy: Adaptation to the Medical Domain** March 2014
Invited Speaker, Computer Science Colloquium
Rensselaer Polytechnic Institute, Troy NY
- UIMA in IBM Watson** March 2014
Guest Lecturer, Computer Science Course: "Semantic Technologies in IBM Watson"
Columbia University, New York NY

UIMA in IBM Watson**March 2013**

Guest Lecturer, Computer Science Course: "Semantic Technologies in IBM Watson"
Columbia University, New York NY

Building Watson: An Overview of the DeepQA Project for the Jeopardy! Challenge**Feb 2012**

Invited Speaker, Computer Science Colloquium
University of Utah, Salt Lake City UT

Building Watson: An Overview of the DeepQA Project for the Jeopardy! Challenge**Oct 2011**

Invited Speaker, External Speaker Series
Knight Capital Group, Jersey City NJ

TEACHING

Instructor, **'Teach the Teacher' Course**
IBM, Argentina

Jul 2016

Visiting Professor, **Semantic Technologies for Automatic Question Answering**
ECI 2016 Winter School, University of Buenos Aires

Jul 2016

Guest Instructor, **Cognitive Computing: Question Answering Technologies Behind Watson**
IBM Online Course: <http://ibm.com/watsonacademy>

Mar 2015

Teaching Assistant, **Machine Learning**
School of Computing, University of Utah

Fall 2003

Teaching Assistant, **Operating Systems Practicum**
Department of Computer Science, University of Minnesota Duluth

Spring 2003

Teaching Assistant, **Introduction to Natural Language Processing**
Department of Computer Science, University of Minnesota Duluth

Fall 2002

Teaching Assistant, **Computer Science II**
Department of Computer Science, University of Minnesota Duluth

Spring 2002

Teaching Assistant, **Computer Science I**
Department of Computer Science, University of Minnesota Duluth

Fall 2001
