Pramod Anantharam

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Passionate about learning from data to solve challenging problems using machine learning & AI techniques

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Education

- **Wright State University**   Dayton, USA
  Doctor of Philosophy (PhD) in Computer Science and Engineering   *May 2009 - April 2016*
    - Dissertation title: *Knowledge-empowered Probabilistic Graphical Models for Physical-Cyber-Social Systems*

- **Visvesvaraya Technological University**   Bangalore, India
  Bachelor of Engineering (BE) in Electrical and Electronics   *2002 - 2006*

Awards & Recognition

- 2015 Selected to participate in the NSF-funded Data Science Workshop at University of Washington, Seattle, Aug 5–7.

- 2015 Our ACM Transactions on Intelligent Systems (TIST) Journal paper was a featured article on the ACM TIST website and the 5th most downloaded article.

- 2014 Offered the Eric & Wendy Schmidt Data Science for Social Good Fellowship.

- 2013 A short article on my research appeared in Wright State University newsroom.

- 2013 Invited to attend Dagstuhl Seminar on Physical-Cyber-Social Computing.

- 2013 Invited to present my work on *Data Analytics for Internet of Things (IoT)* at University of Debrecen, Hungary.

- 2012 NSF travel award for attending the International Semantic Web Conference (ISWC).

- 2012 Best research showcase award for my internship work at IBM Research, India.

Community Presence and Professional Activities

• Published in ACM Transactions on Intelligent Systems and Technology Journal (TIST), Association for Advancement of Artificial Intelligence (AAAI), SIAM International Conference on Data Mining (SDM) • 430+ citations • Two awarded patents

- Program Committee member for: The 16th International Semantic Web Conference - 2017, Web Intelligence Journal - 2017, IEEE Transactions on Industrial Informatics - 2017, IEEE Internet of Things Journal - 2016, Data Mining and Knowledge Discovery Journal - 2016, Semantics and Knowledge track at 26th International World Wide Web (WWW) Conference, ESWC 2016, Web Science track at WWW 2016, Semantics and Big Data track at WWW 2016, Semantic Sensor Networks and Terra Cognita (SSN-TC) at ISWC 2015, Journal of Internet Services and

Applications, The 14th International Semantic Web Conference - 2015, The 6th Workshop on Semantics for Smarter Cities (S4SC 2015) at ISWC 2015, Web Science Track at WWW 2015, 5th Workshop on Semantics for Smarter Cities at ISWC 2014, Second International Workshop on Internet of Things, in Conjunction with CollaborateCom 2014, Semantic Sensor Network Workshop at ISWC 2013, The 13th International Semantic Web Conference - 2014, The ICSE 2014 Workshop on Inclusive Web Programming, Hypertext 2014, Web Science Track at WWW 2014, SSN Workshop at ISWC 2013, DeRiVE Workshop, The 12th International Semantic Web Conference - 2013, International Joint Conference on Artificial Intelligence 2013

- Society Membership: SIAM (Society for Industrial and Applied Mathematics)

Professional Experience

- **Bezirk, Robert Bosch LLC**   Pittsburgh, PA, USA
  Research Scientist, IoT Personalization Technologies   *May 2016 - Present*
  Keywords: Personalization, recommender systems, ranking algorithms, evaluation metrics for ranking algorithms

  - Constantly keep abreast of innovations and technology trends in Personalization in IoT domain to constantly push towards next generation products
  - Develop new ideas and prototypes to demonstrate possible technical directions and value proposition by communicating ideas to both technical and business teams
  - Collaborate to design and implement software encapsulating new ideas and prototypes that utilize IoT Personalization in retail domain

- **Bosch Research and Technology Center**   Pittsburgh, PA
  Research Intern   *May 2014 - Aug 2014*
  Keywords: Task assistance, reinforcement learning, Markov Decision Process (MDP), policy formulation

  - This project was geared toward assisting people in Do-It-Yourself (DIY) tasks in the Internet of Things (IoT) environment.
  - I worked on representation of tasks and recommendation of step-by-step instructions to accomplish DIY tasks.
  - Specifically, I was able to formulate a MDP based approach for task recommendation. Further, I worked on transforming domain knowledge of tasks (such as task complexity and resource requirements) into MDP parameters.
  - My work was deployed as a task recommendation module into a larger IoT middleware designed by Bosch.

- **University of Surrey**   Guildford, United Kingdom
  Visiting Doctoral Student   *Sep 2013 - Dec 2013*
  Keywords: Information extraction, entity spotting, conditional random field (CRF), unstructured textual data

  - This project was a multi-institution European Union (EU) project with nine institutions across industry and academia.
  - At Center for Communications Systems Research (CCSR), I worked closely with Dr. Payam Barnaghi on the problem of extracting city traffic-related events from Twitter.

- Specifically, I proposed algorithms to extract traffic events from short text messages from a city and compared it with ground-truth data from city authorities with promising results.

- **IBM Research** — Delhi, India.
  Research Intern — *Jun 2012 - Sep 2012*
  Keywords: Information extraction, entity spotting, Bayesian Networks, event-aware route recommendation

  - My work focused on leveraging dynamic SMS updates of traffic incidents from city authorities in the city of Delhi to assess its impact on traffic. Further, I worked on updating static schedule of public transport vehicles with extracted dynamic traffic related events.
  - The result of my internship work was integrated into a journey planner used to provide event-aware route recommendation for commuters.
  - My work received *best research showcase award* during poster presentation by all the interns.

- **IBM Research** — Delhi, India.
  Research Intern — *Jun 2011 - Sep 2011*
  Keywords: Ontology evolution, Bayesian Reasoning, beta distribution, smart city ontology

  - In this IBM Smart Planet initiative project, I worked on devising Bayesian reasoning techniques to evolve a Smart City ontology.
  - The ontology had concepts and relationships describing various systems in a city, e.g. departments and services offered by them. Services offered by different departments may vary from one city to the other.
  - Departments in a city may choose to add or remove new service offerings. Starting from a core ontology, incoming evidences (terms extracted from domain specific documents) were analyzed to evolve the core ontology.

- **Hewlett-Packard Global Soft Ltd** — Bangalore, India.
  Software Engineer — *Jul 2006 - Dec 2008*
  Keywords: Software development, Shell scripting, application migration, content management applications

  - I was responsible to develop and enhance various software applications involving content management systems.
  - I was responsible for many application migrations that were part of DCC (Data Center Consolidation) project.
  - Some technical skills gained are shell scripting, software development in Java, and use of Documentum for content management applications.

- **Honeywell Technology Solutions Lab** — Bangalore, India.
  Intern — *Feb 2006 - May 2006*
  Keywords: Remote sensor monitoring, micro-controllers, sensor interfacing, Internet protocols

  - We were tasked to develop an Internet-enabled device that monitored a set of sensors attached to it and reported the sensor observations to a remote database.
  - People or applications could use these observations and take appropriate action based on sensor states.
  - This project was implemented using C programming language.

Research Experience

- **Graduate Research Assistant** — Kno.e.sis
  Lead Researcher, Sustainability and IoT — Jan 2012 - April 2016
    - Keywords: Event extraction from text, sensor data analysis, time series analysis, anomaly detection, linear dynamical systems
    - Collaboration: CityPulse consortium, IBM Research
    - Extraction of traffic-related events in a city from social data (e.g., SMS messages, Twitter)
    - Modeling and understanding traffic dynamics using time series models
    - Understanding city traffic-related events utilizing both sensor and social data streams

- **Graduate Research Assistant** — Kno.e.sis
  Lead Researcher, kHealth for Asthma — Dec 2012 - April 2016
    - Keywords: Asthma management, active sensing, passive sensing, sensors and mobile devices
    - Collaboration: Dayton Children's
    - Lead the development of sensor-enabled mobile application for collecting asthma-related observations from personal, public, and population level sources
    - Completed a pilot study involving six patients with promising results in combining active sensing (user involved in data collection) with passive sensing (user not involved in data collection)
    - Took lead in writing a NIH proposal which was funded and now an active research project

- **Graduate Research Assistant** — Kno.e.sis
  Team member, Semantic Sensor Web project — Sep 2009 - Dec 2011
    - Keywords: Knowledge representation, sensor modeling, observation modeling, annotation, trustworthiness, Bayesian models
    - Experience in modeling sensors and their observations using the W3C Semantic Sensor Network ontology for various applications and sponsor requirements
    - Assessing trustworthiness of sensor nodes utilizing Bayesian approaches
    - Implemented a Bayesian reputation system for over 30,000 weather stations accessed using MesoWest, a massive aggregator of weather sensor data

- **Teaching Assistant** — Computer Science Dept., Wright State University
  C programming lab — Sep 2009 - March 2010
    - Responsible for teaching basic C programming and conducting lab sessions

- **Graduate Research Assistant** — Kno.e.sis
  Team member, Twitris project — Feb 2009 - Aug 2009
    - Keywords: Text processing, relevance ranking
    - Worked on algorithms to fetch relevant multimedia content from various sources based on the event descriptors.

- **Graduate Research Assistant** — Kno.e.sis
  Team member, T.cruzi project — Feb 2009 - Aug 2009
    - Keywords: Semantic technologies, Resource Description Framework (RDF), Web Ontology Language (OWL), SPARQL Protocol and RDF Query Language (SPARQL)
    - Responsible for ontology-driven RDF translation of relational data
    - Explored tools like D2RQ engine, Jena, and other APIs for reading and writing RDF data

Patents

Co-inventor of 2 US Patents

- US20150006644 A1: Assessing Impact of Events on Public Transportation Network

- US20140372364 A1: A System and Method for Utility-Based Evolution in a Constrained Ontology

Tutorials

- **Pramod Anantharam**, Amit Sheth, and Payam Barnaghi, Data Processing and Semantics for Advanced Internet of Things (IoT) Applications: modeling, annotation, integration, and perception, at the International Conference on Web Intelligence, Mining, and Semantics (WIMS 13), Madrid, Spain, June 12 - 14, 2013.

- Krishnaprasad Thirunarayan and **Pramod Anantharam**, Trust Networks: Interpersonal, Sensor, and Social, In: Proceedings of 2011 International Conference on Collaborative Technologies and Systems (CTS 2011), Philadelphia, Pennsylvania, USA, May 23-27, 2011.

Publications

1 Journal Papers

- Krishnaprasad Thirunarayan, **Pramod Anantharam**, Cory Henson, and Amit Sheth, Comparative Trust Management with Applications: Bayesian Approaches Emphasis, In the Journal of Future Generation Computer Systems (FGCS), Elsevier, 25 pages, May 2013, http://dx.doi.org/10.1016/j.future.2013.05.006 [Impact Factor: 2.63]

- **Pramod Anantharam**, Payam Barnaghi, Krishnaprasad Thirunarayan, and Amit Sheth. 2015. Extracting city traffic events from social streams. ACM Trans. Intell. Syst. Technol. 6, 4, Article 43 (June 2015), 27 pages. DOI: http://dx.doi.org/10.1145/2717317

2 Conference and Workshop Papers

- Amit Sheth, **Pramod Anantharam** and Cory Henson, Semantic, Cognitive, and Perceptual Computing: Paradigms That Shape Human Experience, in Computer, vol. 49, no. 3, pp. 64-72, Mar. 2016. doi: 10.1109/MC.2016.75

- **Pramod Anantharam**, Krishnaprasad Thirunarayan, Surendra Marupudi, Amit Sheth, and Tanvi Banerjee. (2016) Understanding City Traffic Dynamics Utilizing Sensor and Textual Observations. at The Thirtieth AAAI Conference on Artificial Intelligence (AAAI-16), February 12–17, Phoenix, Arizona, USA (accepted).

- Tanvi Banerjee, **Pramod Anantharam**, William L. Romine, Larry Lawhorne, and Amit Sheth, Evaluating a Potential Commercial Tool for Healthcare Application for People with Dementia , International Conference on Health Informatics and Medical Systems (HIMS), July 27-30, 2015, Las Vegas, USA.

- **Pramod Anantharam**, Tanvi Banerjee, Amit Sheth, Krishnaprasad Thirunarayan, Surendra Marupudi, Vaikunth Sridharan, and Shalini G. Forbis, Knowledge-driven Personalized Contextual mHealth Service for Asthma Management in Children , IEEE 4th International Conference on Mobile Services, June 27 - July 2, 2015, New York, USA.

- Pratikkumar Desai, Amit Sheth, and **Pramod Anantharam**, Semantic Gateway as a Service architecture for IoT Interoperability , IEEE 4th International Conference on Mobile Services, June 27 - July 2, 2015, New York, USA.

- Amit Sheth, **Pramod Anantharam**, and Krishnaprasad Thirunarayan, kHealth: Proactive Personalized Actionable Information for Better Healthcare, Workshop on Personal Data Analytics in the Internet of Things (PDA@IOT 2014), collocated at VLDB 2014, Hangzhou, China, September 5th, 2014.

- Barnaghi, Payam, Ralf Tnjes, Jan Höller, Manfred Hauswirth, Amit Sheth, and **Pramod Anantharam**. Citypulse: Real-time iot stream processing and large-scale data analytics for smart city applications. In Europen Semantic Web Conference (ESWC) 2014. 2014.

- Amit Sheth, **Pramod Anantharam**, Krishnaprasad Thirunarayan, Applications of Multimodal Physical (IoT), Cyber and Social Data for Reliable and Actionable Insights , Second International Workshop on Internet of Things (C-IOT 2014) In conjunction with IEEE CollaborateCom 2014, Oct 22nd, 2014, Miami, Florida.

- **Pramod Anantharam** and Biplav Srivastava. 2013. City Notifications as a Data Source for Traffic Management. In Proceedings of the 20th ITS World Congress 2013, October 14-18, 2013, Tokyo, Japan.

- **Pramod Anantharam**, Biplav Srivastava, and Amit Sheth. 2013. Utility-driven evolution recommender for a constrained ontology. In Proceedings of the 3rd International Conference on Web Intelligence, Mining and Semantics (WIMS '13). ACM, New York, NY, USA, Article 14, 11 pages. DOI=10.1145/2479787.2479794 http://doi.acm.org/10.1145/2479787.2479794

- **Pramod Anantharam**, Payam Barnaghi, and Amit Sheth. 2013. Data processing and semantics for advanced internet of things (IoT) applications: modeling, annotation, integration, and perception. In Proceedings of the 3rd International Conference on Web Intelligence, Mining and Semantics (WIMS '13). ACM, New York, NY, USA, , Article 5 , 5 pages. DOI=10.1145/2479787.2479821 http://doi.acm.org/10.1145/2479787.2479821

- Amit Sheth and **Pramod Anantharam**. 2013. Physical cyber social computing for human experience. In Proceedings of the 3rd International Conference on Web Intelligence, Mining and Semantics (WIMS '13). ACM, New York, NY, USA, , Article 1 , 7 pages. DOI=10.1145/2479787.2479865 http://doi.acm.org/10.1145/2479787.2479865

- **Pramod Anantharam**, Krishnaprasad Thirunarayan, and Amit Sheth, Traffic Analytics using Probabilistic Graphical Models Enhanced with Knowledge Bases, 2nd International Workshop on Analytics for Cyber-Physical Systems (ACS-2013) at SIAM International Conference on Data Mining (SDM13), pp. 13-20, Texas, USA, May 2-4, 2013.

- Amit Sheth, **Pramod Anantharam**, and Cory Henson, Physical-Cyber-Social Computing: An Early 21st Century Approach, IEEE Intelligent Systems, pp. 79-82, Jan./Feb. 2013.

- Smith, Gary Alan, Amit P. Sheth, Ashutosh Sopan Jadhav, Hemant Purohit, Lu Chen, Michael Cooney, Pavan Kapanipathi, **Pramod Anantharam**, Pramod Koneru, and Wenbo Wang. "Twitris+: Social media analytics platform for effective coordination." (2012).

- **Pramod Anantharam**, Krishnaprasad Thirunarayan, and Amit Sheth, Topical Anomaly Detection for Twitter Stream, In the Proceedings of ACM Web Science 2012, In Conjunction with NetSci 2012 Evanston, Illinois, June 22-24, 2012.

- **Pramod Anantharam**, Alan Smith, Josh Pschorr, Krishnaprasad Thirunarayan, and Amit Sheth, Demonstration: Dynamic Sensor Registration and Semantic Processing for ad-hoc MOBile Environments (SemMOB), In: Proceedings of 5th International Workshop on Semantic Sensor Networks 2012 (SSN 2012), co-located with the 11th International Semantic Web Conference (ISWC 2012), Boston, USA, 2012.

- Pratikkumar Desai, Cory Henson, **Pramod Anantharam**, and Amit Sheth, SECURE: Semantics Empowered resCUe Environment, In: Proceedings of 4th International Workshop on Semantic Sensor Networks 2011 (SSN 2011), co-located with the 10th International Semantic Web Conference (ISWC 2011), Bonn, Germany, pp. 110-113, 2011.

- Krishnaprasad Thirunarayan and **Pramod Anantharam**, Trust Networks: Interpersonal, Sensor, and Social, In: Proceedings of 2011 International Conference on Collaborative Technologies and Systems (CTS 2011), pp. 13-21, Philadelphia, Pennsylvania, USA, May 23-27, 2011 (invited paper).

- **Pramod Anantharam**, Cory A. Henson, Krishnaprasad Thirunarayan, and Amit P. Sheth, Trust Model for Semantic Sensor and Social Networks: A Preliminary Report, In: Proceedings of 2010 National Aerospace & Electronics ConferenceDayton, OH, USA, July 14-16, 2010.

- Krishnaprasad Thirunarayan, **Pramod Anantharam**, Cory A. Henson, and Amit P. Sheth, Some Trust Issues in Social Networks and Sensor Networks, In: Proceedings of 2010 International Symposium on Collaborative Technologies and Systems (CTS 2010), Chicago, IL, May 17-21, 2010.

- Ashutosh Jadhav, Hemant Purohit, Pavan Kapanipathi, **Pramod Ananthram**, Ajith Ranabahu, Vinh Nguyen, Pablo Mendes, Gary Alan/Allen Smith, Michael Cooney, and Amit P. Sheth, Twitris 2.0 : Semantically Empowered System for Understanding Perceptions From Social Data, Demo submitted to, 9th International Semantic Web Conference, ISWC 2010, Shanghai, China, November 7-11, 2010.

- Satya S. Sahoo, D. Brent Weatherly, Raghava Mutharaju, **Pramod Anantharam**, Amit P. Sheth, and Rick L. Tarleton, Ontology-driven Provenance Management in eScience: An Application in Parasite Research, OnTheMove Federated Conferences & Workshops (OTM 2009) - ODBASE'09, Vilamoura, Algarve-Portugal, Nov 03 - 04 - 05, 2009.

- Ashutosh Jadhav, Wenbo Wang, Raghava Mutharaju, **Pramod Anantharam**, Vinh Nyugen, Amit P. Sheth, Karthik Gomadam, Meenakshi Nagarajan, and Ajith Ranabahu, Twitris: Socially Influenced Browsing, Semantic Web Challenge 2009, 8th International Semantic Web Conference, Oct. 25-29 2009, Washinton, DC, USA.

- **Pramod Anantharam**, Satya S. Sahoo, D. Brent Weatherly, Flora Logan, Raghava Mutharaju, Amit P. Sheth, and Rick Tarleton, Trykipedia: Collaborative Bio- Ontology Development using Wiki Environment, Ohio Collaborative Conference on BioInformatics (OCCBIO 2009), June 14-17, 2009.

- Raghava Mutharaju, Satya S. Sahoo, D. Brent Weatherly, **Pramod Anantharam**, Flora Logan, Amit P. Sheth, and Rick Tarleton, 'Ontology Driven Integration of Biology Experiment Data', Ohio Collaborative Conference on BioInformatics (OCCBIO 2009), June 14-17, 2009.

3   Technical Reports

- **Pramod Anantharam**, Krishnaprasad Thirunarayan, Vahid Taslimi, and Amit Sheth, Predicting Parkinson's Disease Progression with Smartphone Data, Technical Report, Submitted to the Parkinson's disease challenge sponsored by The Michael J. Fox Foundation for Parkinson's Research, March, 2013.

- **Pramod Anantharam**, Biplav Srivastava, Raj Gupta, Dynamic Update of Public Transport Schedules in Cities Lacking Traffic Instrumentation, IBM Research Technical Report 2014.

Courses (relevant to my research)

Artificial Intelligence, Information Retrieval, Probability and Statistics for Engineers, Programming Languages, Computational Complexity, Algorithm Design, Knowledge Representation and Semantic Web, Communications in Science, Machine Learning *(Coursera)* , Statistical Learning *(Stanford Online)* , Probabilistic Graphical Models *(Coursera)*

Technical Skills

Solving Data Problems
• Supervised Learning (Bayesian Networks, Conditional Random Field, Linear Regression, Logistic Regression, Decision Trees, Random Forest, Support Vector Machine, Neural Networks) • Unsupervised learning (Clustering temporal data, clustering user preferences) • Time Series Models (Linear Dynamical Systems, Hidden Markov Models, ARIMA) • Recommender Systems (user preference representation & learning, ranking algorithms, evaluation metrics) • Reinforcement learning (Markov Decision Process)
Databases
• MySQL • Virtouso • Jena • Neo4j
Languages
• Programming: Python, Java, R, Matlab, Shell, PHP, Scheme, Java Script, • Knowledge Representation: RDF, RDFS, OWL

Professional References

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  Wright State University
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