

1 NURALI VIRANI

2 *Research Scientist, Machine Learning, GE Research*

3 EDUCATION/TRAINING:

INSTITUTION AND LOCATION	DEGREE	Completion Date	FIELD OF STUDY
Indian Institute of Technology (IIT) Kharagpur, India	B. Tech.	07/2011	Manufacturing Science (Robotics)
Indian Institute of Technology (IIT) Kharagpur, India	M. Tech.	07/2011	Industrial Engineering (Optimization)
Pennsylvania State University, University Park, PA, USA	M. S.	05/2015	Mechanical Engineering (Time-series analysis)
Pennsylvania State University, University Park, PA, USA	M. S.	12/2016	Electrical Engineering (Game theory)
Pennsylvania State University, University Park, PA, USA	Ph. D.	02/2017	Mechanical Engineering (Data-driven Modeling)

4 A. Research and Professional Experience

5 Dr. Nurali Virani is a Research Scientist in the Machine Learning team under AI organization at GE
6 Research. He is a multidisciplinary researcher with a strong academic and research background in
7 machine learning, statistical modeling, optimization theory, control theory, sensor fusion, signal
8 processing, motion planning, and mechatronics. He works on designing, developing, and deploy-
9 ing algorithms to systematically address some challenges in learning and control. He has worked
10 on several projects including: 1) AI-driven control of wind farms, 2) active learning for surrogate
11 modeling and sequential optimization of oil reservoirs, 3) learning from demonstration in tele-robotics,
12 4) AI-driven safe control of power generation units, and 5) insider threat detection for cybersecu-
13 rity (IARPA SCITE). He is also a member in GE team on the DARPA ASKE program to automatically
14 create computational graphs from semantic knowledge graphs curated from code, documenta-
15 tion, and publications with human-in-the-loop. His current research interest is in making AI aware
16 of its competence and to improve its competence via continuous learning (*Humble AI*) as well as
17 making AI consistent with human knowledge.

18 Prior to joining GE, he was a research assistant at Penn State with primary assistantship from
19 U. S. Air Force Office of Science and Research (AFOSR). His research was on data-driven modeling
20 of context using statistical learning, nonparametric methods for density estimation, Bayesian sen-
21 sor fusion, and Markov decision processes for context-aware sensor selection in multi-modal sur-
22 veillance. As a part of Networked Robotics and Systems Lab, he worked on game theory and
23 robust optimization for his MS thesis in Electrical Engineering. In Penn State, he was key
24 researcher on *Intelligent Sensor Fusion for Fault Detection* project from U. S. Office of Naval
25 Research (ONR) and *Sensor Array Fusion for Border-Crossing Target Detection and Classification*
26 from U. S. Army Research Office (ARO). He was awarded a silver medal for academic excellence,
27 when he graduated from Indian Institute of Technology in 2011.

28 B. Collaborators and Affiliations

- 29 • Asok Ray, Pennsylvania State University
- 30 • Shashi Phoha, Pennsylvania State University
- 31 • Minghui Zhu, Pennsylvania State University
- 32 • Devesh Jha, Mitsubishi Electric Research Lab
- 33 • Faith Rose Beck, Pennsylvania State University
- 34 • Lokanath Mohanta, UTC Climate Control and Security
- 35 • Robert Klenner, Energy and Environmental Research Center
- 36 • Steve Piche, GE Power

37 • Brian Barr, Capital One

38 **C. Publications and Synergistic Activities**

39 **Publications**

40 Virani, N., Phoha, S. and Ray, A., 2018. Learning from Multiple Imperfect Instructors in Sensor
41 Networks. IEEE Transactions on Neural Networks and Learning Systems, (99), pp.1-7.

42 Virani, N., Lee, J.W., Phoha, S. and Ray, A., 2014, December. Dynamic Context-Aware Sensor
43 Selection for Sequential Hypothesis Testing. In 53rd IEEE Conference on Decision and Control
44 (pp. 6889-6894). IEEE.

45 Virani, N., Lee, J.W., Phoha, S. and Ray, A., 2015, July. Learning Context-Aware Measurement
46 Models. In 2015 American Control Conference (ACC) (pp. 4491-4496). IEEE. (**Best Presenta-**
47 **tion in Session (Machine Learning) Award**)

48 Virani, N. and Zhu, M., 2016, July. Robust adaptive motion planning in the presence of dynamic
49 obstacles. In 2016 American Control Conference (ACC) (pp. 2104-2109). IEEE.

50 Virani, N., Jha, D.K., Yuan, Z., Shekhawat, I. and Ray, A., 2018. Imitation of Demonstrations using
51 Bayesian Filtering with Nonparametric Data-Driven Models. Journal of Dynamic Systems,
52 Measurement, and Control, 140(3), p.030906.

53 **Book Chapters**

54 Virani, N., Sarkar, S., Lee, J.W., Phoha, S. and Ray, A., "Algorithms for Context Learning and
55 Information Representation for Multi-Sensor Teams," in *Context-Enhanced Information*
56 *Fusion*, edited by L. Snidaro *et al.*, Springer, 2016

57 Virani, N., Phoha, S. and Ray, A., "On Compression of Machine-derived Context Sets for Fusion of
58 Multi-modal Sensor Data," in Springer DDDAS.

59 **D. Awards**

60 • GE Global Research CTO Technology Award for Outstanding Research (5 Under 5), 2018

61 • Institute Silver Medal from IIT Kharagpur

62 • Prof. G. S. Sanyal Cup from IIT Kharagpur for Best Outgoing Student in Technology 2011

63 • Aga Khan Foundation International Scholarship 2011-13

64 • Aga Khan Youth Award for Excellence 2013 for Outstanding Special Achievements

65 • Proficiency Award for Best Project in M. Tech. in Industrial Engineering in 2011 at IIT Kharag-
66 pur

67 • Proficiency Award for Best Project in B. Tech. in Manufacturing in 2010 at IIT Kharagpur

68 • Best Student Paper Award at 2016 ACM SIGKDD Workshop on Machine Learning for Prognos-
69 tics and Health Monitoring

70 • 2 GE Impact Awards in 2018

71 • 3 GE Above & Beyond Awards in 2017

72 **ANDREW W. CRAPO**

73 *Principle Scientist, GE Research*

74 **A. Education/Training**

INSTITUTION AND LOCATION	DEGREE	Completion Date	FIELD OF STUDY
Brigham Young University	B.S.	08/1975	Physics & Math
University of Central Florida	M.S.	1980	Energy Systems
Rensselaer Polytechnic Institute	Ph.D.	12/2002	Decision Sciences and Engineering Systems

75 **B. Research and Professional Experience**

76 GE Research (April 1980 – present)

- 77 • Developed models of electric vehicle battery packs, power plant scrubbing systems, coal gas-
78 ification plants, fuel cells
- 79 • Created a graphical expert system knowledge capture and decision support tool suite
- 80 • Created the Semantic Application Design Language (SADL) to enable subject matter experts to
81 understand and create semantic models
- 82 • Created the SADL Requirements Language (SRL) to capture formal requirements in a struc-
83 tured-English representation suitable for translation to requirements analysis (theorem prov-
84 ing) and test case generation
- 85 • Developed Dialog, a mixed-initiative language for human-computer collaboration for DARPA
86 ASKE (research on-going)

87 **C. Publications and Synergistic Activities**

- 88 • A. Moitra, K. Siu, A.W. Crapo, H. Chamarthi, M. Durling, M. Li, H. Yu, P. Manolios, M. Meiners.
89 Towards Development of Complete and Conflict-Free Requirements. IEEE Requirements Engi-
90 neering Conference (RE'18), Banff, Canada, Aug 22-25, 2018.
- 91 • A. Moitra, A. Crapo, R. Palla. Concept-level Rules for Capturing Domain Knowledge. 12th IEEE
92 International Conference on Semantic Computing, Jan 31-Feb 2, 2018.
- 93 • Siu, Kit, et al, Flight Critical Software and Systems Development Using ASSERT™, 2017
94 IEEE/AIAA 36th Digital Avionics Systems Conference (DASC), 17-21 Sept, 2017.
- 95 • Crapo, Andrew, Abha Moitra, Craig McMillan, and Daniel Russell, Requirements Capture and
96 Analysis in ASSERT™, IEEE 25th International Requirements Engineering Conference (RE)
97 2017, Lisbon Portugal, 4-8 Sept. 2017.
- 98 • A. Crapo, S. Gustafson. "Semantics: Revolutionary Breakthrough or Just Another Way of Doing
99 Things?" Semantic Web: Implications for Technologies and Business Practices. Ed. M Work-
100 man. Springer International, 2016. 85-118. Print.
- 101 • A. Crapo, A. Moitra. Toward a unified English-like representation of semantic models, data,
102 and graph patterns for subject matter experts. International Journal of Semantic Computing,
103 Vol. 7, No. 3, 2013, pp. 215-236.

- 104 • S.J. Dill, B. Barnett, A. Crapo, A. Moitra. Method and apparatus for providing information
105 assurance attributes through a data providence architecture. Patent # 8,495,736. July 23,
106 2013.
- 107 • S.J. Dill, B. Barnett, A. Crapo, A. Moitra. Method and apparatus for simulating a workflow and
108 analyzing the behavior of information assurance attributes through a data providence archi-
109 tecture. Patent # 8,452,962. May 28, 2013.
- 110 • S.J. Dill, B. Barnett, A. Crapo, A. Moitra. Method and apparatus for monitoring and analyzing
111 degree of trust and information assurance attribute information in a data providence archi-
112 tecture workflow. Patent # 8,281,141. October 2, 2012.
- 113 • S.J. Dill, B. Barnett, A. Crapo, A. Moitra. Method and apparatus for generating a figure of merit
114 for use in transmission of messages in a multi-level secure environment. Patent # 8,166,122.
115 Apr. 24, 2012.
- 116 • US Patent 8166122: Method and Apparatus for Generating a Figure of Merit for Use in Trans-
117 mission of Messages in a Multi-Level Secure Environment, 2012.
- 118 • Barnett, Bruce and Andrew Crapo. A Semantic Model for Cyber Security. Grid Interop 2011.
- 119 • A. Moitra, A.W. Crapo, M.A. Bodkin. System and method for automating the generation of an
120 ontology from unstructured documents. Patent # 7,987,088. July 26, 2011.
- 121 • US Patent 20100251374 A1: Method and Apparatus for Monitoring and Analyzing Degree of
122 Trust and Information Assurance Attributes in a Data Provenance Architecture Workflow,
123 2010.
- 124 • A. Crapo, K. Griffith, A. Khandelwal, J. Lizzi, A. Moitra, X. Wang. Overcoming Challenges Using
125 the CIM as a Semantic Model for Energy Applications. Grid Interop Dec. 2010.
- 126 • A. Moitra, B. Barnett, A. Crapo, S.J. Dill. Addressing Uncertainty and Conflicts in Cross-Domain
127 Data Provenance. MILCOM2010, Nov 2010, pp. 1764-1769.
- 128 • A. Moitra, B. Barnett, A. Crapo, S.J. Dill. Data Provenance Architecture to Support Assurance in
129 a Multi-Level Secure Environment. MILCOM2009, Oct 2009.

130 **ABHAY HARPALE**

131 *Senior Research Scientist, GE Global Research*

132 **A. Education/Training**

INSTITUTION AND LOCATION	DEGREE	Completion Date	FIELD OF STUDY
SGGS, Nanded, India	Bachelor of Engineering	June 2002	Computer Science
Indian Institute of Technology Bombay, Mumbai, India	Master of Technology	June 2004	Information Technology
Carnegie Mellon University, Pittsburgh, PA, US	Ph.D.	August 2012	Machine Learning

133 **B. Research and Professional Experience**

134 **GE Global Research (2012 – Present) Senior Research Scientist, San Ramon, CA, US**

135 Anomaly detection for aviation, power and water, renewable energy, and nuclear energy.

136 *Employee performance summarization:*

137 Training curriculum, jobs, roles, and skillset recommendation

138 Jet engine prognostics

139 Oil and gas pipeline diagnostics

140 Gas turbine degradation modeling and root cause analysis

141 Time-series classification

142 Flight arrival estimation

143 Relevance-based sentiment analysis

144 *Topics:* Prognostics, text-mining, probabilistic graphical models, topic models, time-series mining

145 Carnegie Mellon University (2006 – 2012) Graduate Research Assistant, Pittsburgh, PA, US

146 Never Ending Language Learner with Prof. Tom Mitchell

147 User-centric Adaptive and Collaborative Filtering with Prof. Yiming Yang

148 *Topics:* active learning, adaptive filtering, collaborative filtering, personalized search, classifica-

149 tion, protein identification

150 Yahoo Research (2010) Summer Intern, Advertising Sciences Lab, Santa Clara, CA, US

151 *Topics:* Personalized click-response prediction using user-generated social content for behavioral

152 Ad-targeting

153 **Intel (2004 – 2006) Software Engineer, Technology Management Team, Bangalore, India**

154 *Topics:* Smart e-manuals for information sharing and troubleshooting. Tutoring workflow man-

155 agement systems

156 **Xurmo (2011-2012) Machine Learning Research Advisor, Bangalore, India**

157 *Topics:* personalized enterprise search, expert discovery, sentiment analysis

158 **C. Collaborators and Affiliations**

159 • Prof. Yiming Yang, Carnegie Mellon University

160 • Prof. Christos Faloutsos, Carnegie Mellon University

161 • Prof. Jamie Callan, Carnegie Mellon University

162 • Prof. Jaime Carbonell, Carnegie Mellon University

163 • Prof. Sunita Sarawagi, IIT Bombay

- 164 • Prof. U. Kang, KAIST, South Korea
- 165 • Prof. Vagelis Papalexakis, University of California, Riverside

166 **D. Publications and Synergistic Activities**

167 **Publications**

- 168 • Abhay Harpale and Abhishek Srivastav: A textual transform of multivariate timeseries for
- 169 prognostics. CoRR abs/1709.06669 (2017)
- 170 • Evangelos E. Papalexakis, U. Kang, Christos Faloutsos, D. Sidiropoulos, Abhay Harpale: Large
- 171 Scale Tensor Decompositions: Algorithmic Developments and Applications. IEEE Data Eng.
- 172 Bull. (3): 59-66 (2013)
- 173 • U Kang, Evangelos Papalexakis, Abhay Harpale, and Christos Faloutsos. GigaTensor: Scaling
- 174 Tensor Analysis Up By 100 Times - Algorithms and Discoveries. KDD 2012.
- 175 • Abhay Harpale and Yiming Yang. Multi-Task Active Learning for Hierarchical Classification.
- 176 (under review)
- 177 • Abhay Harpale and Yiming Yang. Transferable Active Learning for Heterogeneous Tasks. (under
- 178 review)
- 179 • Abhay Harpale, Yiming Yang, Siddharth Gopal, Daqing He and Zhen Yue. CiteData: A new
- 180 multi-faceted dataset for evaluating personalized search performance. CIKM 2010.
- 181 • Abhay Harpale and Yiming Yang. Active Learning for Multi-Task Adaptive Filtering. ICML 2010.
- 182 • Zhen Yue, Abhay Harpale, Daqing He, Jonathan Grady, Yiling Lin, Jon Walker, Siddharth Gopal,
- 183 and Yiming Yang. CiteEval for Evaluating Personalized Social Web Search. SIGIR 2009, In the
- 184 Future of IR Evaluations workshop.
- 185 • Yiming Yang, Abhay Harpale, and Subramaniam Ganapathy. Protein Identification from Tan-
- 186 dem Mass Spectra with Probabilistic Language Modeling. ECML-PKDD 2009.
- 187 • Yiming Yang, Subramaniam Ganapathy, and Abhay Harpale. Protein Identification as an Infor-
- 188 mation Retrieval Problem. SIGIR 2009.
- 189 • Abhay Harpale, Yiming Yang. Personalized Active Learning for Collaborative Filtering. SIGIR
- 190 2008.
- 191 • Yiming Yang, Abhimanyu Lad, Ni Lao, Abhay Harpale, Bryan Kisiel, Monica Rogati, Jian Zhang,
- 192 Jaime Carbonell, Peter Brusilovsky, Daqing He: Utility-based information distillation over tem-
- 193 porally sequenced documents. SIGIR 2007
- 194 • Shantanu Godbole, Abhay Harpale, Sunita Sarawagi, Soumen Chakrabarti. Document classifi-
- 195 cation through interactive supervision of document and term labels. ECML-PKDD 2004
- 196 • Shantanu Godbole, Abhay Harpale, Sunita Sarawagi, Soumen Chakrabarti. HIClass: Hyper
- 197 Interactive text Classification by interactive supervision of document and term labels. ECML-
- 198 PKDD 2004

199 **Patents**

- 200 • Abhay Harpale, Jobin James, Abhishek Srivastav, and Jianbo Yang. A method for detection of
- 201 HVAC anomalies and failures at the component level. Filed 2017.
- 202 • Abhay Harpale. Temporal Transduction for automatic prognostics, diagnosis and change point
- 203 detection. Filed 2016.
- 204 • Helena Goldfarb, Abhay Harpale, Achalesh Pandey, and Huang Hao. Machine Learning Tem-
- 205 plates in Digital Twin Framework. Filed 2016.
- 206 • Abhay Harpale, Shiva Kasiviswanathan, Anuj Tewari, and Jobin James. Automatic summariza-
- 207 tion of employee performance. Filed 2015.

- 208 • Abhay Harpale, Hao Huang, Achalesh Pandey, and Alex Narkaj. System and method for unsu-
209 pervised anomaly detection on industrial timeseries data. Filed 2015.
- 210 • Abhay Harpale, Abhishek Srivastav, and Mohak Shah. A Text-Mining approach for diagnostics
211 and prognostics using temporal multi-dimensional sensor observations. Filed 2014.

212 **Service**

- 213 • Journals: ACM Pattern Recognition, IEEE Transactions on the Web. IEEE Transactions on
214 Cybernetics
- 215 • Conferences: International conference on Machine Learning (ICML), SIAM Data Mining (SDM),
216 Special interest group in Information Retrieval (SIGIR)

217 **VARISH MULWAD**

218 *Lead Scientist, GE Research*

219 **A. Education/Training**

INSTITUTION AND LOCATION	DEGREE	Completion Date	FIELD OF STUDY
University of Mumbai, Mumbai, India	B.E.	12/2007	Computer Engineering
University of Maryland, Baltimore County, Baltimore, MD, USA	M.S.	08/2010	Computer Science
University of Maryland, Baltimore County, Baltimore, MD, USA	Ph.D.	05/2015	Computer Science

220 **B. Research and Professional Experience**

221 GE Research (March 2018 – present) Lead Scientist (Location: Niskayuna, NY, USA)

- 222 • Developing NLP algorithms for extraction of scientific concepts and equations from text as
223 part of DAPRA's Automating Scientific Knowledge Extraction program.
- 224 • Leading a research collaboration with UMBC for learning to extract relations from text with
225 limited examples (form of learning with less labels)
- 226 • Lead researcher and developer for an internal NLP framework used in several projects.
- 227 • Work on authoring and submission of govt. research proposals as Principal Investigator and
228 key contributor

229 GE Research (August 2015 – March 2018) Knowledge Discovery Researcher (Location: Niskayuna,
230 NY, USA)

- 231 • Led the development of an AI agent for IT Tech agents - AI assists in classifying IT tickets into
232 categories, recommends possible resolutions for new problems and recommends experts that
233 can assist in resolving new issues. The AI agent is deployed in production and is used by GE's IT
234 tech agents.
- 235 • Part of the team that developed NLP algorithms for concept extraction from medical docu-
236 ments and recommendation of relevant document from patient history to radiologists; Led
237 the transition of algorithms into GE Healthcare's medical imaging software product.

238 Ebiquity Research Lab, UMBC (April 2015 – July 2015) Post-doctoral Research Associate (Loca-
239 tion: Baltimore, MD, USA)

- 240 • Projects: Text analysis of Social Media data & Automatic Interpretation of Log Files to support
241 Cybersecurity.

242 Ebiquity Research Lab, UMBC (Sep. 2009 – Mar. 2015) Research Assistant (Location: Baltimore,
243 MD, USA)

- 244 • Research projects: 1) Extracting concepts describing security vulnerabilities from text; 2) Info-
245 boxer: Using Statistical and Semantic Knowledge to Help Creating Wikipedia Infoboxes.
- 246 • Gained experience in writing grant proposals by contributing to govt. and industry proposals.

247 Microsoft Research (May 2012 – August 2012) Research Intern (Location: Redmond, WA, USA)

248 • Project focused on information extraction from text descriptions associated with apps in the
249 Windows Phone Store. Mentor: Dr. Evelyn Viegas. US patent 9558275 issued based on
250 internship work.

251 Microsoft Bing (June 2011 – August 2011) Software Development Engineer Intern (Location: Bel-
252 levue, WA, USA)

253 • Developed a prototype to demonstrate the use of entity disambiguation to improve search
254 results.

255 • Two disclosures filed with Microsoft for patent consideration.

256 C. Collaborators and Affiliations

257 • Prof. Tim Finin, University of Maryland, Baltimore County

258 • Prof. Karuna Pande Joshi, University of Maryland, Baltimore County

259 • Prof. Tim Oates, University of Maryland, Baltimore County

260 • Prof. Anupam Joshi, University of Maryland, Baltimore County

261 D. Publications and Synergistic Activities

262 **Publications: (Total citations: 426 • h-index: 10 • i10-index: 11 [as of Apr. 2019; via**
263 **Google Scholar])**

264 Book Chapters

265 • **Varish Mulwad**, Tim Finin and Anupam Joshi, “A Domain Independent Framework for Extract-
266 ing Linked Semantic Data from Tables”, In Search Computing, ISBN 978-3-642-34212-7, vol.
267 7538, 2012.

268 Conferences

269 • Justin McHugh, Paul Cuddihy, Jenny Williams, Kareem Aggour, Vijay Kumar, and **Varish Mul-**
270 **wad**, “Integrated Access to Big Data Polystores through a Knowledge-driven Framework”, IEEE
271 Int. Conf. on Big Data, Boston, MA, USA, 2017.

272 • Sudip Mittal, Prajit Kumar Das, **Varish Mulwad**, Anupam Joshi, and Tim Finin, “CyberTwitter:
273 Using Twitter to generate alerts for cybersecurity threats and vulnerabilities”, In 2016
274 IEEE/ACM Int. Conf. on Advances in Social Networks Analysis and Mining (ASONAM), San Fran-
275 cisco, CA, USA, 2016.

276 • Piyush Nimbalkar, **Varish Mulwad**, Nikhil Puranik, Anupam Joshi, and Tim Finin, “Semantic
277 Interpretation of Structured Log Files”, In 17th IEEE Int. Conf. on Information Reuse and Inte-
278 gration (IRI), Pittsburgh, PA, USA, 2016.

279 • **Varish Mulwad**, Tim Finin and Anupam Joshi, “Interpreting Medical Tables as Linked Data to
280 Generate Meta-Analysis Reports”, In 15th IEEE Int. Conf. on Information Reuse and Integra-
281 tion (IRI 2014), San Francisco, CA, USA, 2014.

282 • **Varish Mulwad**, Tim Finin and Anupam Joshi, “Semantic Message Passing for Generating
283 Linked Data from Tables”, In 12th Int. Semantic Web Conf. (ISWC 2013), Sydney, Australia,
284 2013.

285 • Zareen Syed, Tim Finin, **Varish Mulwad**, and Anupam Joshi, “Exploiting a Web of Semantic
286 Data for Interpreting Tables”, In 2nd Web Science Conf. (WebSci 2010), Raleigh, NC, USA,
287 2010.

288 Doctoral Consortium

289 • **Varish Mulwad**, “DC Proposal: Graphical Models and Probabilistic Reasoning for Generating
290 Linked Data from Tables”, In 10th Int. Semantic Web Conf. (ISWC 2011), Bonn, Germany, 2011.

291 **Workshops**

- 292 • Luis Tari, **Varish Mulwad**, Anna von Reden, “Interactive online learning for clinical entity rec-
293 ognition”, In Proceedings of the Workshop on Human-In-the-Loop Data Analytics (HILDA ’16),
294 held at SIGMOD, San Francisco, CA, 2016
- 295 • **Varish Mulwad**, Tim Finin and Anupam Joshi, “Automatically Generating Government Linked
296 Data from Tables”, In AAAI Fall Symposium on Open Government Knowledge: AI Opportunities
297 and Challenges (OGK 2011), Arlington, VA, USA, 2011.
- 298 • **Varish Mulwad**, Tim Finin and Anupam Joshi, “Generating Linked Data by Inferring the Seman-
299 tics of Tables”, In 1st Int. Workshop on Searching and Integrating New Web Data Sources
300 (VLDS 2011), held at 37th Int. Conf. on Very Large Databases (VLDB 2011), Seattle, WA, USA,
301 2011.
- 302 • **Varish Mulwad**, Wenjia Li, Anupam Joshi, Tim Finin and Krishnamurthy Viswanathan,
303 “Extracting Information about Security Vulnerabilities from Web Text”, In Web Intelligence for
304 Information Security Workshop, held at IEEE/WIC/ACM Int. Conf. on Intelligent Agent Technol-
305 ogy (WI-IAT 2011), Lyon, France, 2011.
- 306 • **Varish Mulwad**, Tim Finin, Zareen Syed and Anupam Joshi, “Using linked data to interpret
307 tables”, In 1st Int. Workshop on Consuming Linked Data, held at the 9th Int. Semantic Web
308 Conf. (ISWC 2010), Shanghai, China, 2010.

309 **Poster and Demos**

- 310 • Paul Cuddihy, Justin McHugh, Jenny Weisenberg Williams, **Varish Mulwad**, Kareem S. Aggour,
311 “SemTK: A Semantics Toolkit for User-friendly SPARQL Generation and Semantic Data Man-
312 agement”, In 17th Int. Semantic Web Conf. (ISWC 2018), Monterey, CA, USA, 2018.
- 313 • Roberto Yus, **Varish Mulwad**, Tim Finin, and Eduardo Mena, “Infoboxer: Using Statistical and
314 Semantic Knowledge to Help Create Wikipedia Infoboxes”, In 13th Int. Semantic Web Conf.
315 (ISWC 2014), Riva del Garda, Italy, 2014.
- 316 • **Varish Mulwad**, Tim Finin, Zareen Syed and Anupam Joshi, “T2LD: Interpreting and Represent-
317 ing Tables as Linked Data” In 9th Int. Semantic Web Conf. (ISWC 2010), Shanghai, China, 2010.

318 **Patents Granted**

- 319 • Luis Tari, **Varish Mulwad**, “System and Method for Entity Recognition and Linking”, United
320 States Patent 10,146,859, 2018.
- 321 • Anna Von Reden, **Varish Mulwad**, Eric Fluharty, Ethan Winograd, Tao Jing, “Display Screen or
322 Portion Thereof with Graphical User Interface”, United States Patent D821,423, 2018.
- 323 • Evelyne Viegas, **Varish Mulwad**, Patrick Pantel, “Action Broker”, United States Patent
324 9,558,275, 2017.

325 **Patents Filed**

- 326 • **Varish Mulwad**, Ivan Bueno, Raghava Mutharaju, “Apparatus, System and Method for Provid-
327 ing an Agent That Intelligently Solves Information Technology Issues”, United States Patent
328 Application, 2018
- 329 • **Varish Mulwad**, Kareem Aggour, “Systems and Methods for Learning to Extract Relations from
330 Text via User Feedback”, United States Patent Application, 2017.
- 331 • S.M. Gustafson, K.S. Aggour, A. Gabaldon Royval, **V. Mulwad**, “Methods and Systems for Pro-
332 gramatically Selecting Predictive Model Parameters”, United States Patent Application, 2016.

333 **Activities**

- 334 • Co-organizer, “Knowledge Graph Technology and Applications” workshop at the Web Conf.
335 2019
- 336 • Co-organizer, “Industrial Knowledge Graphs” workshop at the ACM Web Science Conf. 2017
- 337 • President, UMBC ACM student chapter (2012 – 2013)
- 338 • Significant contributions to the National Science Foundation (NSF) proposal “EAGER: T2K:
339 From Tables to Knowledge”; awarded (\$200,000); PI – Dr. Anupam Joshi; CO-PI – Dr. Tim Finin.
- 340 • Significant contributions to FFRDC Seed Grant proposal, “Supporting Situation-Aware Systems
341 for Automated Information Sharing and Incident Response”; awarded (\$50,000); PI – Dr.
342 Zareen Syed (UMBC)
- 343 • Program Committee Member
 - 344 —57th Annual Meeting of the Association for Computational Linguistics [Social Media Area]
345 (ACL 2019)
 - 346 —28th Int. Joint Conf. on Artificial Intelligence (IJCAI 2019)
 - 347 —Poster & Demo track for Int. Semantic Web Conf. (2016, 2017, 2018, 2019)
 - 348 —Poster & Demo track for Extended Semantic Web Conf. (2017, 2018, 2019)
 - 349 —Int. Workshop on Natural Language Interfaces for Web of Data (NLIWoD 2018)
 - 350 —Workshop on Knowledge Base Construction, Reasoning and Mining (2018)
 - 351 —In-Use Track for Int. Semantic Web Conf. (2017)
 - 352 —Int. Workshop on Linked Data for Information Extraction (2014, 2015, 2016, 2017).
 - 353 —28th AAAI Conf. on Artificial Intelligence (AAAI 2014)
 - 354 —2nd Mid-Atlantic Student Colloquium on Speech, Language and Learning (MASC-SLL
355 2012)
 - 356 —1st Int. Workshop on Knowledge Discovery and Data Mining Meets Linked Open Data
357 (Know@LOD 2012 at ESWC 2012)
- 358 • Reviewer
 - 359 —External reviewer ACM conference for Human-Computer Interaction (CHI 2016)
 - 360 —Sub reviewer 30th AAAI Conf. on Artificial Intelligence (AAAI 2016)
 - 361 —ACM Transactions on the Web (TWEB) (2014)
 - 362 —IEEE Transactions on Knowledge and Data Engineering (TKDE) (2013)
 - 363 —The VLDB journal’s special issue on Structured, Social and Crowd-sourced Data (VLDBJ)
364 (2012)
 - 365 —IEEE Intelligent Systems special issue on Linked Open Government Data (2011).

366 **ALBERTO SANTAMARIA-PANG**

367 *Principal Scientist, GE Global Research*

368 **A. Education/Training**

INSTITUTION AND LOCATION	DEGREE	Completion Date	FIELD OF STUDY
University of Veracruz, Mexico	B.S.	09/1995 - 09/2001	Mathematics
University of Houston, Texas	Ph.D.	09/2003 - 12/2007	Computer Science
University of Houston, Texas	Post-doc	12/2007 - 08/2008	Biomedical Image Analysis

369 **B. Personal Statement**

370 I have more than 10 years of experience in image analysis, machine learning and data analysis for
371 object segmentation, classification and quantification. I have contributed and lead projects on
372 industrial and government funded projects in areas related to biomedical imaging. The image
373 analysis technology that I have developed is fundamental to identify biomarkers on a cell-by-cell
374 basis for a cancer patient. This information is critical to quantify specific biomarker expression at
375 the sub-cellular level and provides the ability to construct unique cancer signatures for cancer
376 patients. This image technology improves the ability to accurately identify biomarkers and to
377 make more informed choices on therapies to prescribe, as well as therapies to avoid, based on a
378 patient's specific type of cancer and on the progress of the disease. Additionally, this image anal-
379 ysis technology enables physicians to identify cells within a tumor that are believed to be the can-
380 cer-causing agents.

381 In addition, I have conducted research in different areas of medical imaging including: 1) auto-
382 matic methods to extracting medial axis in neurons from three-dimensional microscopy data, 2)
383 three-dimensional image denoising, 3) developing segmentation methods using deformable
384 models with applications to coronary artery shape analysis from EBCT data, and 4) machine learn-
385 ing algorithms for tissue analysis in microscopy imaging, leading to 15 patents filed/granted and
386 over 40 peer-reviewed publications.

387 **C. Professional Experience**

388 04/2018-present Principal Scientist, Artificial Intelligence Group, GE Global Research

389 01/2015-01/2017 Adjunct Professor, Dept. of Biomedical Engineering, Rensselaer Polytechnic
390 Institute

391 08/2008-04/2011 Lead Scientist, Biomedical Image Analysis Group, GE Global Research

392 06/2005-09/2005 Research Intern, Siemens Medical Solutions, Malvern, PA

393 **D. Positions and Honors**

394 **Positions and Employment**

395 01/2008-07/2008 Postdoc, Computationally Biology Lab, University of Houston

396 01/2003-12/2007 Research Assistant, Computationally Biology Lab, University of Houston

397 01/1999-01/2000 Research Assistant, National Laboratory of Advanced Informatics, Veracruz,
398 Mexico

399 **Recent Experience and Professional Memberships**

400 2017-2018 IEEE BHI 2017 - Session on Imaging Informatics, Chair

401 2018-2019 IEEE ISBI 2019 Organizing Committee - Industry Liaison Chair

402 **AWARDS**

403 • 1993: Second Place in Regional Contest of Mathematics, Olympiads of Science

404 • 1993: Third Place in State Contest of Physics, Olympiads of Science 1999: Student Travel Stipend, Mexican Mathematical Society, Course in Differential Geometry

405 • 1999: Student travel stipend, Mexican Mathematical Society, XXXII Conference of the Mexican Mathematical Society

406 • 2009: Technical team achievement award for outstanding contribution in the Molecular Pathology Program at GE Global Research

407 • 2009: Edelheit Award, for excellence in innovation and technical content outstanding contribution in the Dual Energy City Program, GE Research

408 • 2010: Whitney Award, Molecular Pathology Program, GE Research

413 **E. Contribution to Science**

414 **Tissue-Based Image Analytics – Oncology and Neuro-Pathology**

415 I have lead research of novel algorithms for tissue classification via machine learning algorithms (model-based, deep and shallow machine learning) for tissue characterization, cell phenotyping and clinical correlations. Recently, I lead the development of Artificial Intelligence algorithms with applications in immune-therapies, allowing the robust characterization of multiple cell types (more than 16 phenotypes) with more than 40 markers expressed in the same tissue. These algorithms enable the analysis of very large cohorts: more than 100 subjects, and thousands of images that contain approximately 40 markers in the same tissue section with a reported accuracy of approximately of 90%. The algorithms I have develop are currently used in GE Healthcare products for Tissue-Based analysis and used by researchers in clinical trials, basic biology and drug discovery.

425 • **A. Santamaria-Pang**, R.K. Padmanabhan, A. Sood, M. J. Gerdes, C. Sevinsky, Q. Li, N. LaPlante, F. Ginty, “Robust single cell quantification of immune cell subtypes in histological samples”, IEEE EMBS International Conference on Biomedical & Health Informatics (BHI), 2017 (Oral Presentation)

429 • A. Chowdhury, D.V. Dylov, Q. Li, M. MacDonald, D.E. Meyer, M. Marino, **A. Santamaria-Pang**, “Blood vessel characterization using virtual 3D models and convolutional neural networks in fluorescence microscopy”, IEEE 14th International Symposium on Biomedical Imaging (ISBI), 2017

433 • E.T. McKinley, Y. S., Y. Al-Kofahi, B. A. Millis, M. J. Tyska, J. T. Roland, **A. Santamaria-Pang**, C. L. Ohland, C. Jobin, J. L. Franklin, K. S. Lau, M. J Gerdes, R. J Coffey, “Optimized multiplex immunofluorescence single-cell analysis reveals tuft cell heterogeneity”, JCI insight, 2017

436 • A. Chowdhury, C.J. Sevinsky, **A Santamaria-Pang**, B. Yener, “A computational study on convolutional feature combination strategies for grade classification in colon cancer using fluorescence microscopy data”, Medical Imaging: Digital Pathology, 2017

439 **Neuro Science Image Analytics**

440 During my Ph.D., I designed and implemented a framework for 3D shape reconstruction and analysis of neuron cells from optical imaging. I developed and implemented methods for: 3D noise removal in optical images, neuron dendrite detection, and a robust algorithm for rapid reconstruction of neurons. I collaborated with biologists and neuroscientists in designing and implementing computer vision algorithms to guide biological experiments. Using the neuron morpho-

logical reconstructions provided by the ORION software, researchers at the Baylor College of Medicine in Houston, TX explore complex models of neuron function. Also, a database of neurons is being acquired so that neuroscientists can study the morphological patterns of neuron's associated with different pathologies, such as Alzheimer's disease, and to enable a better understanding of the brain during the aging process.

- **A. Santamaria-Pang**, P. Hernandez-Herrera, M. Papadakis, P. Saggau, I. Kakadiaris, "Automatic Morphological Reconstruction of Neurons from Multiphoton and Confocal Microscopy Images Using 3D Tubular Models", *Neuroinformatics*, pp. 1539-2791, 2015
- **A. Santamaria-Pang**, T.S. Bildea, S. Tan, I.A. Kakadiaris. "Denoising for 3D photon-limited imaging data using nonseparable filterbanks", *IEEE Trans Image Process.*, 17(12):2312-23, 2008
- I.A. Kakadiaris, **A. Santamaria-Pang**, C.M. Colbert, P. Saggau, "Morphological Reconstruction of Living Neurons", *Microscopic Image Analysis for Life Science Applications*, Eds. J. Rittscher, R. Machiraju, and S. T. C. Wong, 2008
- B.E. Losavio, Y. Liang, **A. Santamaria-Pang**, I.A. Kakadiaris, C.M. Colbert and P. Saggau, "Live Neuron Morphology Automatically Reconstructed from Multiphoton and Confocal Imaging Data", *Journal of Neurophysiology* 100.4 (2008): 2422-2429

Medical Image Analysis

While working with GE Healthcare and the Mayo Clinic, Scottsdale, I developed a method for automatic liver lesion characterization using dual energy computed tomography imaging. As a result of this contribution I was granted the Imaging Technologies (ImT) Edelheit Team Award for excellence in innovation and technical content. This award is available to the member whose exceptional technology has been commercialized and enabled GE to differentiate a product or service in the marketplace. Also, I published his research in the SPIE 2010 Conference in Computer Aided Diagnostics, where his paper was accepted as an oral presentation (less than 5% of the work was selected for oral presentation).

- **A. Santamaria-Pang**, S. Dutta, S. Makrogiannis, A. Hara, W. Pavlicek, A. Silva, B. Thomsen S. Robertson, D. Okerlund, D.A. Langan, Rahul Bhotika, "Automated liver lesion characterization using fast kVp switching dual energy computed tomography imaging." *SPIE Medical Imaging*, pp. 76240V-76240V. International Society for Optics and Photonics, 2010
- I.A. Kakadiaris, **A. Santamaria-Pang**, A. Pednekar, "Functional morphology analysis of the left anterior descending coronary artery in EBCT images", *IEEE Trans Biomed Eng.* Aug;57(8):1886-96, 2010
- I.A. Kakadiaris, A. Pednekar, and **A. Santamaria-Pang**, "Three-dimensional Shape-motion Analysis of the Left Anterior Descending Coronary Artery in EBCT Images," *Proc. Medical Image Computing and Computer-Assisted Intervention (MICCAI)*, Rennes, Saint-Malo, France, pp. 1025-1033, Sept 26-30, 2004

F. Publications

My complete list of published work can be found in: <https://scholar.google.com/citations?user=sVahJxsAAAAJ&hl=en>; https://www.researchgate.net/profile/Alberto_Santamaria-Pang

G. Research Support

Completed Research Support

Immune Cell Analytics, Santamaria-Pang (Project Lead, GE Internal) 01/01/2015-01/01/2016
The goal of this project was to develop robust machine learning algorithms for robust segmentation and classification of immune cells.

491 Role: Developed algorithms and coordinated efforts in analyzing and validation multiple immune
492 cell phenotyping on Cell-DIVE platform.

493 Modeling Dynamics of Salivary Gland, Larsen (Project Lead, SUNY) NIH/NIDCR RO1DE019244
494 8/1/2008 – 7/31/15

495 We applied a serial multiplexed fluorescent immunohistochemistry technology to map the pro-
496 gressive refinement of the epithelial and mesenchymal cell populations throughout development
497 from embryonic day 14 through postnatal day 20. Using computational single cell analysis meth-
498 ods, we simultaneously mapped the evolving temporal and spatial location of epithelial cells
499 expressing subsets of differentiation and progenitor markers throughout salivary gland develop-
500 ment.

501 Role: Developed analytical algorithms and software for robust single cell segmentation using
502 multi-channel makers.

503 Single Cell Analysis Program (SCAP), Gerdes (Project Lead, GE), NIH RO1CA174377 01/01/2012-
504 01/01/2014

505 The purpose of this program was to develop technologies for single cell analysis in tissue for the
506 use of multiplexing, more than 60 markers.

507 Role: Developed image analysis algorithms for hierarchical single cell segmentation and tissue
508 classification.

509 **Ongoing Research Support**

510 Neuro Pathology Cell Analytics, Meyer (Project Lead, GE Internal) 01/01/2015-Present

511 The program is focused in developing algorithms for robust brain cell classification and heteroge-
512 neity metrics to identify vulnerable cells from CellDive platform.

513 Role: Developed algorithms and software platform for interactive segmentation of cells using
514 machine learning and active learning methods.

515 Immune Response in DCSI, Badve (Project Lead, NCI, R01CA194600) 8/4/15 – 7/31/19

516 The goal of this program is to develop an ethnicity-based immune response profiling in *in situ*
517 tumors Ductal Carcinoma In Situ (DCIS) which can predict risk of the development for invasive
518 breast cancer. Understanding the ethnicity- based immune responses in *in situ* tumors has an
519 enormous potential to prevent and control breast cancer

520 Role: Developed analytics for detection and clinical correlation of panel of immune cell analysis in
521 DCIS.

522 **SHIRAJ SEN**

523 *Lead Scientist, GE Research*

524 **A. Education/Training**

INSTITUTION AND LOCATION	DEGREE	Completion Date	FIELD OF STUDY
Indian Institute of Technology Kharagpur	B.S.	2002	Mathematics & Computing
Indian Institute of Technology Kharagpur	M.S.	2004	Mathematics & Computing
University of Massachusetts Amherst	M.S.	2007	Computer Science
University of Massachusetts Amherst	Ph.D.	2012	Computer Science

525 **B. Research and Professional Experience**

526 GE Research, Niskayuna, NY 2014 – present

527 Lead Scientist - Robotics and Autonomous Systems (2016 – present); Research Engineer (2014 -
528 2016)

529 Accomplished roboticist responsible for researching and developing robotic solutions (aerial,
530 ground, crawling) for autonomous field robotics applications in the Military, Aviation, Energy, and
531 Transportation domain. Highly regarded for technical and execution skills and the ability to work
532 with multi-disciplinary teams to build complex systems.

533 • Leading a team to research and develop capabilities for multi-robot collaborative autonomy
534 and manned-unmanned teams with applications in the military and industrial domain.

535 • Led a multi-disciplinary technical team to develop next generation technologies around
536 autonomous inspection using aerial robotic systems. The technology led to the creation of a
537 new business (<http://www.avitas-systems.com/>) for automated infrastructure inspection.

538 • Led a team to develop perception system for robots that work autonomously in rail-yard envi-
539 ronments. Responsibilities included developing the technical strategy, architecting the sys-
540 tem, integration of the various sub-systems, and reporting out to internal and external
541 stakeholders.

542 • Collaborated to develop and demonstrate Validation and Verification methods for designing
543 trustworthy robotic systems. This work led to a best paper award at a conference.

544 • Successfully competed in the NASA Space Robotics Challenge to develop and demonstrate
545 technologies for robots working in bandwidth constrained environments, such as that on
546 Mars.

547 Postdoctoral Research Associate, University of Massachusetts Amherst, MA 2013 – 2014

548 • Developed Bayesian estimation and information theoretic planning techniques to perform
549 real-time action selection for various robotic tasks that scale to thousands of object models.
550 The technique has been demonstrated on multiple robots including NASA Robonaut-2.

551 Graduate Research Assistant, University of Massachusetts Amherst, MA 2004 – 2012

552 • Researched POMDP and Information-theoretic planning techniques to perform reasoning
553 under uncertainty for mobile manipulation tasks.

- Led the design and implementation of a knowledge representation framework for integrated learning, planning, and control.
- Researched Reinforcement Learning techniques for autonomous robot learning. Demonstrated the capability on multiple bimanual robots.
- Successfully implemented a bottom up robot-control architecture in MRDS and ROS that allows for knowledge transfer among multiple robots.
- Selected to compete in the prestigious DARPA sponsored Autonomous Robot Manipulation project. Developed new algorithms and approaches that enable robots to autonomously grasp and manipulate objects in unstructured environments.

C. Collaborators and Affiliations

- Prof. Roderic Grupen, University of Massachusetts Amherst
- Prof. Andy Barto, University of Massachusetts Amherst

D. Publications and Synergistic Activities

- **S. Sen**, B. Miller, J. Reimann, B. Good, S. Gray, J. Hoare, C. Theurer, Training Manned-Unmanned teams via Curriculum-based Learning. In 2019 IEEE Conference on Robotics and Automation, Workshop on Robot Teammates Operating in Dynamic Unstructured Environments, May 2019.
- J. Hoare, J. Foehner, S. Gray, **S. Sen**, H. Tan, K. Macdonald, Tele-robotic control of Autonomous Mobile robots for Industrial applications using Virtual Reality. In 2018 IEEE Conference on Robot and Human Interactive Communication, August 2018.
- K. Siu, A. Moitra, P. Manolios, M. Durling, A. Crapo, M. Li, H. Yu, C. McMillan, H. Herencia-zapana, M. Castillo-Effen, **S. Sen**, D. Russell, S. Roy, Flight Critical Software and Systems Development using ASSERT. In 2017 IEEE/AIAA 36th Digital Avionics Systems Conference. (**Winner of Best of Track and Best of Session Paper award**)
- S. Li, A. Jain, P. Sharma and **S. Sen**, A perception system for detecting brake levers in outdoor rail yard environments. In 2016 International Conference on Intelligent Robots and Systems, October 2016.
- H. Tan, **S. Sen**, A. Jain, S. Li, V. Holovashchenko, G. Baloch, O. Al Assad, R. Patrick, D. Forman, Y. Gefen, P. Sharma, F. Wheeler, C. Theurer and K. Balajee, An Integrated Robotic System for Autonomous Brake Bleeding in Rail Yards. In 2016 International Conference on Intelligent Autonomous Systems, July 2016.
- L. Ku, **S. Sen**, E. Learned-Miller and R. Grupen, Aspect Transition Graph: An Affordance-Based Model. In European Conference on Computer Vision, Workshop on Affordances: Visual Perception of Affordances and Functional Visual Primitives for Scene Analysis, September 2014.
- L. Ku, **S. Sen**, E. Learned-Miller and R. Grupen, Action-Based Models for Belief-Space Planning. In Proceedings of RSS 2014 Workshop on Information-based Grasp and Manipulation Planning, July 2014.
- **S. Sen** and R. Grupen, Manipulation Planning using Model-Based Belief Dynamics. Proceedings of the Thirteenth IEEE-RAS International Conference on Humanoid Robots, October 2013.
- **S. Sen**, G. Sherrick, D. Ruiken and R. Grupen, Choosing Informative Actions for Manipulation Tasks. In Proceedings of the Eleventh IEEE-RAS International Conference on Humanoid Robots, October 2011.

- 596 • **S. Sen**, G. Sherrick, D. Ruiken and R. Grupen, Hierarchical Skills and Skill-based Representa-
597 tion. In Proceedings of the AAAI Workshop on Lifelong Learning from Sensorimotor Experi-
598 ence, August 2011.
- 599 • S. Hart, **S. Sen**, S. Ou and R. Grupen, The Control Basis API - A Layered Software Architecture
600 for Autonomous Robot Learning, In ICRA Workshop on Software Development and Integra-
601 tion in Robotics, May 2009.
- 602 • S. Hart, **S. Sen** and R. Grupen, Generalization and Transfer in Robot Control, In Eighth Interna-
603 tional Conference on Epigenetic Robotics, July 2008.
- 604 • S. Hart, **S. Sen** and R. Grupen, Intrinsically Motivated Hierarchical Manipulation, In Proceed-
605 ings of the IEEE International Conference on Robotics and Automation, May 2008.
- 606 • P. Keegan, R. Grupen, A. Hanson, E. Harrell, S. Ou, E. Rise-man, **S. Sen**, B. Thibaud, A. Williams
607 and D. Xi, Mobile Manipulators for Assisted Living in Residential Settings. In Journal for Auton-
608 omous Robots, 2007.
- 609