Reports on the 2015 AAAI Spring Symposium Series

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■ *The AAAI 2015 Spring Symposium Series was held Monday through Wednesday, March 23–25, at Stanford University near Palo Alto, California. The titles of the seven symposia were Ambient Intelligence for Health and Cognitive Enhancement, Applied Computational Game Theory, Foundations of Autonomy and Its (Cyber) Threats: From Individuals to Interdependence, Knowledge Representation and Reasoning: Integrating Symbolic and Neural Approaches, Logical Formalizations of Commonsense Reasoning, Socio-Technical Behavior Mining: From Data to Decisions, Structured Data for Humanitarian Technologies: Perfect Fit or Overkill? and Turn-Taking and Coordination in Human-Machine Interaction. The highlights of each symposium are presented in this report.*

Ambient Intelligence for Health and Cognitive Enhancement

Ambient intelligence (intelligence embedded in the environment) is a system and an information technology that can adapt to human activities in the living environment. As characteristics of ambient intelligence, its system or information technology (1) is embedded in the environment; (2) can recognize the situational context of the subject; (3) can be personalized to the subject; (4) can change in response to the subject; and (5) can anticipate desires of the subject. One of the potential applications in ambient intelligence is health care. For example, a health-monitoring system embedded in the environment is useful for checking the health of aged persons without their entering a hospital, and thus contributes to health enhancement by controlling their health conditions. Another important potential of ambient intelligence from the viewpoint of health care is to enhance our

cognitive capability by using many sensors. For example, health conditions can be more accurately recognized when many vital data from many sensors are used rather than a single vital datum, and this contributes to cognitive enhancement. These aspects suggest that ambient intelligence contributes to our health and cognitive enhancement. In this symposium, we explore methods or methodologies for the following three questions: (1) how to quantify our health and cognitive performance; (2) how to analyze the health and cognitive data for discovering new meanings; and (3) how to design our health and cognitive enhancement space.

To promote discussion on possible solutions for these issues, our symposium brought together an interdisciplinary group of researchers, working in such areas as biomedical informatics, natural language processing, intelligent agent systems, human computer interaction, brain science, cognitive psychology, social science, and behavior science. The symposium included five invited talks and three guest talks to give us new perspectives on health and cognitive enhancement. For example, Steve Cole (HopeLab) introduced the concept of quantified molecular self, which is at the cutting edge of biomedical well-being research paradigms with social genomics technologies. John Chuang (University of California, Berkeley) presented neuroscience challenges for a future ambient intelligence society, with neural technologies. He introduced the concept of pass thought, which is the complimentary privacy technology with password. Chuck Gulash (Toyota Collaborative Safety Research Center) gave a talk on a new safe-driving platform that addresses future automobile ambient intelligence challenges for supporting the driver's cognitive performance. Daniel Sternberg (Lumosity) introduced the data science behind Lumosity's 2.5 billion data points of cognitive game-play performance and provided insights into the lifestyle correlations of cognitive performance. Fahmida N. Chowdhury (National Science Foundation) introduced the NSF's research grant projects on smart connected health. At a guest talk, Dave Miller (Stanford University) presented the idea of gamification with personal data such as individual's email logs.

The technical papers (14 papers and 5 posters or demonstrations) were presented over the course of the two-and-a-half days. Presentation topics included cognitive assistance and health enhancement, automated driving, neurosensing at scale, wearable technologies, ambient intelligence and privacy, genetics technology, imagination and information visitation, and natural language processing.

David Atkinson introduced the Ambient Personal Environment Experiment (APEX), a cyber-human prosthesis for mental, physical, and age-related disabilities. Keiki Takadama reported on an ambient intelligent system for good sleep by adjusting sound to heartbeat and respiration. Tetsuaki Nakamura introduced an advice agent for diet and exercise based on diary texts. Hiromi Arai discussed the preservation of privacy in crowdsourced health research, and Takashi Kido introduced ambient intelligence and crowdsourced genetics for understanding personal cognitive biases in decision making.

The symposium provided participants unique opportunities for researchers from completely different backgrounds to come up with new ideas through innovative and constructive discussions. We expect that further continuing events following this symposium will present important interdisciplinary challenges for guiding future advances in the AI community.

Takashi Kido and Keiki Takadama served as cochairs of this symposium. The papers of the symposium were published as AAAI Press Technical Report SS-15-01.

Applied Computational Game Theory

Game theory is an important paradigm for modeling and analysis for diverse disciplines including economics, biology, political science, computer science, psychology, business, public policy, security, and many others. However, much of game theory studies stylized abstract models that are not directly relevant to real-world decisions. The focus of this symposium is to bring together the community interested in real-world applications of game theory that can be used to inform specific decisions motivated by a wide range of different domains.

One of the primary goals was to bring together researchers from different fields, working on different domains. The speakers and attendees came from areas including behavioral modeling, computational game theory, multiagent robotics, operations research, planning, and machine learning. This led to an energetic discussion of many different methodologies, spanning algorithmic and computational game theory, decision theory, risk analysis, machine learning, and psychology. There were a total of 23 oral presentations, a panel discussion, and two invited talks by Michael Bowling (University of Alberta) and Ali Abbas from the National Center for Risk and Economic Analysis of Terrorism Events (CREATE).

One theme of the symposium was applications of game theory to security. Software tools based on game theory have been successfully deployed to improve the unpredictability of patrolling strategies for ports, airports, flights, and transit systems, and many papers followed up on this line of work by expanding to new areas of security and policing. Papers were presented on applications of game theory for border patrolling, computer network security, infrastructure protection, robotic target tracking, and combating environmental crime such as poaching.

Another cluster of the presentations was motivat-

ed by challenge problems in computer poker, which is a large-extensive form game with incomplete information. The presentations covered new methods for solving very complex games based on abstraction and strategy clustering. The invited talk by Michael Bowling discussed the recent success of the Alberta Poker Group in essentially solving two-player limit Texas Hold 'Em poker using algorithmic advances in computational game theory, representing perhaps the greatest success to date in solving a game with imperfect information played by humans in real competition. Other talks explored the problem of signaling in games, cooperation, teamwork in games, and health domains such as designing vaccines.

There were several common themes among the technical approaches and challenges identified by the researchers that spoke to the common problems we face in applying game theory to real-world problems. First, scalability of solution methods to solve very large, complex game models remains a significant challenge, and many talks focus on algorithmic advances. A second area of investigation is improving the robustness of game theory models to many different forms of uncertainty, and developing new solution techniques that account for these uncertainties. Modeling human behavior more accurately is also a key area of research, along with improving learning methods that can adapt to changes in the situation over time using new data. Finally, validation of game theory models is also an important ongoing area of research.

During the panel discussion, the symposium participants discussed emerging applications of game theory, future directions of research, and how the symposium was useful in bringing together researchers from different fields with different perspectives. The participants engaged in enthusiastic discussions about future symposia on this topic.

The symposium was chaired by Fei Fang, with assistance from the organizing committee of Christopher Kiekintveld, Yevgeniy Vorobeychik, Peter Stone, Bo An, Manish Jain, and Albert Xin Jiang. This report was written by Fei Fang and Christopher Kiekintveld. No technical report was issued.

The Foundations of Autonomy and Its (Cyber) Threats: From Individuals to Interdependence

Approaches using artificial intelligence may soon manage complex systems with teams, including hybrid teams composed arbitrarily of humans, machines, and robots. Already, AI has been useful in modeling the defense of individuals, teams, and institutions, as well as the management of social systems such as virtual ship bridges. However, foundational problems remain in the continuing development of AI for team autonomy, especially with objective measures able to optimize team function, performance, and composition.

Despite its theoretical complexity, including the inherent uncertainty and nonlinearity exposed by interdependence, we argue that complex autonomous systems must consider multiagent interactions to develop predictable, effective, and efficient hybrid teams. Important examples include cases of supervised autonomy, where a human oversees several interdependent autonomous systems; where an autonomous agent is working with a team of humans, such as in a network cyber defense; or where the agent is intended to replace effective, but traditionally worker-intensive team tasks, such as warehousing and shipping. Autonomous agents that seek to fill these roles, but do not consider the interplay between the participating entities, will likely disappoint.

This symposium, attended by representatives from industry, academe, and government, focused on these problems. One theme of discussion was on useful channels of information in a supervisory context. This includes both when humans supervise autonomous agents, and when autonomous agents monitor human teams. For example, when training human teams, it is difficult to understand the effectiveness of the team while the task is being performed without interrupting the team members to collect feedback. To this end, Chris Berka of Advanced Brain Monitoring discussed techniques for real-time monitoring and evaluation of the effectiveness of teams of humans using disparate data including EEG-based metrics, which can be collected in a reasonably unobtrusive way and allow an automated system to provide feedback. Conversely, the scenario may be one in which several autonomous agents are being supervised by a single human. In this situation, it is difficult to keep mission awareness on all the tasks, necessitating clear and concise channels of information that capture many aspects of mission performance. Gavin Taylor of the US Naval Academy discussed this problem and spoke on the use of reinforcement learning as a useful channel of information. Other related topics, included the human-factor considerations in hybrid teams (Naval Research Labs) and trust between humans and autonomous agents (Kristin Schaefer, Army Research Labs).

Participants also discussed techniques for quantifying hybrid team success. These discussions included the use of entropic measures and differential equations and creativity. Finally, the cybersecurity domain was discussed as a particularly important area of concern, providing an interesting domain in which networks and hosts are monitored by autonomous agents, but analysis is performed by human experts. These conversations were led by representatives from the Lincoln Laboratory.

The symposium was organized by Ranjeev Mittu (Naval Research Labs), Gavin Taylor (US Naval Academy), Don Sofge (Naval Research Labs), and W. F.

Lawless (Paine College). This report was written by Gavin Taylor and W. F. Lawless. The papers of the symposium were published in AAAI Technical Report SS-15-02.

Knowledge Representation and Reasoning: Integrating Symbolic and Neural Approaches

Much work on knowledge representation and reasoning in the artificial intelligence community during the 1980s emphasized symbolic representations and logical reasoning. Later symbolic methods fell out of favor as statistical and neural network models showed high accuracy on various problems of interest in AI. Now that both symbolic and neural approaches have gone through multiple dips and rises in prominence, and both are recently seeing significant new empirical successes (for example, massive symbolic knowledge bases such as Freebase, and deep neural networks for machine translation), the symposium organizers thought the time was ripe to bring these two communities together for an open exchange of perspectives and ideas, a search for common ground, and a discussion of recent understanding of human cognition.

Symbolic and neural approaches are each commonly seen as having their own strengths and weaknesses. For example symbolic systems are able to represent knowledge with crisp, transparent rules and operate with long chains of reasoning, while neural systems are able to represent imprecise, generalizable concepts and reason by learning to combine many pieces of weak evidence.

A key, emergent theme of the symposium was the surprising degree to which recent work from both communities is integrating concepts and capabilities from the other. For example Doug Lenat and Michael Witbrock (Cycorp) described recent use of word2vec distributed word representations to aid generalization in the Cyc knowledge base. Peter Clark (Allen Institute for Artificial Intelligence) similarly presented successes in answering fourth-grade science tests in Project Aristo by gaining generalization through a textual entailment service on raw textual phrases in the midst of their otherwise first-order-logic-based system. Correspondingly there were also discussions of neural networks with explicit reasoning structures. For example, Geoff Hinton (University of Toronto) described the representation of a stack data structure in a recursive neural network using stack operations and program counters, stored in a fast associative memory. Antoine Bordes (Facebook) presented a class of neural models called memory networks that employ an explicit collection of readable and writeable long-term memory slots. A somewhat related view was taken by Percy Liang (Stanford) who espoused using the raw web to represent knowledge, and using semantic parsing to answer questions from it on the fly. There were multiple explorations of methods for performing chains of reasoning in neural models by Sam Bowman (Stanford), Guillaume Bouchard (University College London), and Arvind Neelakantan (University of Massachusetts Amherst), as well as methods for extracting transparent rules from learned neural models by Sameer Singh (University of Washington) and reconciling distributed representations with the notion of a small set of semantic primitives by Gemma Boleda (Universitat Pompeu Fabra). In a joint session with the symposium on Logical Formalizations of Commonsense Reasoning, Jerry Hobbs (USC/ISI) described recent progress in making abduction efficient by recasting it as a problem in integer linear programming, and in giving the cost function a probabilistic foundation.

The symposium also aimed to draw inspiration from the latest discoveries about how human minds perform representation and reasoning. Josh Tenenbaum (MIT) advocated for extracting commonsense knowledge not first from language, but from physical objects and intentional agents, as prelingual infants do. Both he and Noah Goodman (Stanford) discussed probabilistic programs as natural representations for reasoning by simulation. Gary Marcus (New York University) closed the symposium by synthesizing many aspects of the symbolic and neural viewpoints, while also arguing that we should not be searching for a single canonical neural circuit or learning mechanism, because cortical diversity itself is so pervasive.

The participants discussed the multiple points of new contact between neural and symbolic approaches, and expressed great interest in reconvening a similar gathering within the next two years.

The cochairs of the symposium were Evgeniy Gabrilovich, Ramanathan Guha, and Kevin Murphy of Google, and Andrew McCallum of University of Massachusetts Amherst. This report was written by Andrew McCallum. The papers of the symposium were published as AAAI Press Technical Report SS-15-03.

Logical Formalizations of Commonsense Reasoning

The cochairs of this symposium were Leora Morgenstern, Theodore Patkos, and Robert Sloan. The papers of the symposium were published as AAAI Press Technical Report SS-15-04. No report of this symposium was submitted by the organizers by press time.

Socio-Technical Behavior Mining: From Data to Decisions

The prevalence of social media and smart handheld devices has irreversibly transformed our communi-

cation, interaction, and information sharing styles, giving rise to novel socio-technical behaviors (for example, hacktivism, self-organization, flash mobs, citizen journalism, tweetcasting, and others). Efficient data analysis techniques are needed to understand and model emerging socio-technical behaviors. Existing studies provide limited understanding of these behaviors. A fundamental and systematic investigation of social media platforms is a precursor to conduct studies at a foundational level filling this critical research gap.

The symposium brought together researchers and practitioners from various disciplinary backgrounds, including (but not limited to), computational and information science, social science, security and digital forensics, mathematics, and economics, among others, to shed light on the emerging socio-technical behaviors and argue that novel research methods and tools are required to develop a comprehensive understanding of such behaviors. The symposium program was broadly categorized into two main themes: social and behavioral computation, and deviant behaviors. The program consisted of seven technical talks and two invited keynotes. The technical talks ranged from analyzing deviant sociotechnical behaviors manifested by dark or terrorist networks to disinformation campaigns or propaganda dissemination to cyber forensics to online behaviors in health communities. These interdisciplinary studies make fundamental as well as methodological contributions to the literature in social network analysis, group dynamics, complex social processes, collective action, sociolinguistic analysis, and computer and information sciences in general.

Under the social and behavioral computation theme, four papers were presented in addition to a keynote delivered by Fahmida Chowdhury, program director for social and economic sciences at the National Science Foundation (NSF). Chowdhury spoke about the various multidisciplinary activities currently underway at NSF emphasizing the need for truly interdisciplinary collaborations to tackle real-world and pressing problems pertaining to social, behavioral, and economic sciences. The four papers presented in this theme resonated with the vision Chowdhury presented. Peggy Wu and colleagues at Smart Information Flow Technologies (SIFT) discussed sociolinguistic-based approaches to identify psycho-social dimensions. Amit Saha and colleagues from the University of Arkansas for Medical Sciences presented a study on autism support communities examining social support mechanisms by bridging blogging and microblogging platforms. In the third paper of this theme, Ibrahim Baggili and colleagues at the University of New Haven discussed research directions that foray into social-cybersecurity, outlining the challenges and opportunities presented by the data available on social media platforms. The last paper in this theme, by atih Sen and colleagues at the Le Bonheur Children's Hospital and University of Tennessee Health Sciences Center, presented a novel approach to analyze focal structures in complex networks by taking examples from biological networks, coordination networks in social movements, and information diffusion networks.

The second theme of the symposium, that is, deviant behaviors, consisted of various studies that examine emerging sociotechnical behaviors that have disturbing implications. Three papers and a keynote delivered by Filipo Menczer of Indiana University highlighted how social media, which is often considered as a positive vehicle of change, could be harnessed to spread misinformation and propaganda and to influence mass thinking. Boris Galitsky at the Knowledge-Trail, Inc., presented a web mining approach to detect rumor and misinformation. Lun-Wei Ku and colleagues at the Academia Sinica in Taiwan discussed data-mining approaches to identify supportive and unsupportive evidence from Facebook using opposition to reconstruction of a nuclear power plant as an example. The last talk by Samer Alkhateeb and colleagues at the University of Arkansas at Little Rock presented a collective action-based theoretical framework to analyze flash mob-style coordination and information diffusion structures observed in cybernetic space to assess security threats ranging from propaganda dissemination to radicalization and recruitment.

The symposium ended with a discussion on the need for creating a repository of interdisciplinary research methodologies, tools, and data that will serve as a collection of resources to spark innovation among researchers working in the area of socio-technical behavior mining, which will in turn push the fringes of knowledge by exploring topics with fluid disciplinary boundaries.

Nitin Agarwal, Huan Liu, and Laurie Fenstermacher served as cochairs for this symposium. This report was written by Nitin Agarwal. The papers of the symposium were published as AAAI Press Technical Report SS-15-05.

Structured Data for Humanitarian Technologies: Perfect Fit or Overkill?

The AAAI 2015 Symposium on Structured Data for Humanitarian Technologies brought together academic researchers, developers, and humanitarian practitioners with the purpose of having a balanced discussion on the merits of structured data in disaster situations. In addition to structured data, another theme that came up very frequently in the symposium was the role that social media plays in a disaster and how to mine the information from that event effectively.

Papers presented at the symposium discussed various topics including existing structured data solutions such as Humanitarian eXchange Language

(HXL), extracting structured data from multilingual Wikipedia edits to provide a social sensor as to what is happening all over the world at a given time, distributed system architectures that can be leveraged in disaster situations, and qualitative analysis on issues that humanitarian practitioners face when they try to adopt and apply structured data technologies in real-world disaster situations.

The symposium included three invited keynote speeches. Andrej Verity from UN OCHA talked about the tools the UN is currently using in disasters (such as MicroMappers, GDELT, KoboToolkit), the data cleaning process, the effort to maintain data collected during and after disasters using structured data ontologies such as HXL, repositories such as the Humanitarian Data Exchange and 3W databases, and more importantly the realities on the ground highlighting the need to find simplified structured data solutions. A key takeaway was to simplify interfaces used by humanitarian practitioners, especially those dealing with complex data processing. Sharad Mehrotra from the University of California, Irvine talked about the challenge of intelligently processing data that flows in during crisis situations, and the research efforts that are underway at the Center for Emergency Response Technologies. Ed Jezerski from InSTEDD talked about leveraging instincts of the experts, wisdom of the crowds, and the scale of algorithms drawing on a lot of experiences from the past disaster relief work he has engaged in. He also provided an overview of the impressive toolkit that his startup InSTEDD has developed.

The symposium included two panels that included a wide range of experts from academia, military, medicine, data science, and humanitarian practitioners. The panel on data-driven disaster response discussed the existing technologies used in disaster response, challenges in using these technologies, how structured data can help in these technologies, and the future of disaster management assuming the data-driven approach. The panel on challenges and prospects of integrating the data-driven approach in large-scale humanitarian operations discussed humanitarian information management systems, challenges in data volume, velocity, variety, veracity and mining, and the role of interoperability through structured data and the uncertainty in data integration. We also had two invited tutorials, one on the crisis mapping pioneering tool Ushahidi by Sara-Jayne Terp, as well as one on the pioneer humanitarian information management system Sahana by Chamindra De Silva's team. These two are the most prominently used disaster-management software systems.

The symposium concluded with several key lessons and opportunities to cocreate solutions for complex humanitarian data challenges. Some of the key insights are summarized in the following paragraphs.

Heterogeneous terminology within the same geography: One of the themes that came up frequently during the symposium is that changing information needs and differences in definitions across geographical boundaries make the standardization of structured data very difficult. Even within the same geographical region, when a disaster strikes, it is very difficult to get all the responding agencies to use the same standard.

Learning curve of structured data technologies: Structured data technologies have a steep learning curve that can be problematic for relief organizations, which usually have a high staff turnover and employ mostly young staff with low experience. Therefore simplicity is paramount. A community-based attribute-tagging scheme that is identified by certain hashtags was agreed to be the best way forward.

There is a need for bridging data providers, processors, and end users: Another theme of the symposium was to find a solution to the societal divides among data collectors/providers, analysis experts, and the end consumers, by including the communities in the data collection process, and feeding them back the results of data analysis to build trust and increase the effectiveness of the intervention.

Being grounded with the technology environment: Data practitioners should be cognizant of the realities on the ground. As mentioned by one of the keynotes, paper and pen is the most effective tool in a crisis; it is a proven reliable technology that is usable in direct sunlight, copes with dusty and rough conditions, does not run out of batteries, and more importantly, is familiar and nonthreatening to the affected population.

Sustainable simple technology solutions where applicable: Another lesson was to find specific pockets of the humanitarian data flow where technology would have the most impact. For researchers, the focus should be on finding that sweet spot where facilitating disaster response with structured data would happen in an easy-to-use and a frictionless manner. It was agreed that information-need-driven technology development with a proper end user in mind would have the greatest usability.

Oshani Seneviratne, Hemant Purohit, and Lalana Kagal served as cochairs of this symposium. The papers of the symposium were be published as AAAI Press Technical Report SS-15-06.

Turn-Taking and Coordination in Human-Machine Interaction

Turn-taking in human-human conversation is an interactive, mixed-initiative, highly coordinated, and inherently multimodal process by which participants synchronize their verbal and nonverbal exchanges during interactions. Regulating turn-taking with artificial systems hinges critically on multimodal sensing, making decisions under uncertainty and time constraints, and coordinating behaviors across differ-

ent output modalities. The turn-taking system must extract and integrate multiple audiovisual signals and knowledge sources to make inferences about user utterances, transition relevance places, floor control actions, speech sources and addresses in multiparty settings, and more.

This symposium brought together researchers from different fields that approach the common problem of turn-taking and coordination from somewhat different angles. The primary purpose was to build more common ground for researchers from these different backgrounds, to share perspectives, methodologies, and results from different investigations into the problem of turn-taking and coordination, and to promote communication, collaboration, and discussion on how to make progress in this space.

A large number of diverse themes were featured in the presentations, including, but not limited to, models of turn-taking; multimodal sensing, inference and decision-making for turn-taking; annotations and characterizations of various turn-taking phenomena; the role of gaze and gesture in turn-taking and grounding; experimental methodologies like Wizard-of-Oz; understanding how various contextual and cultural factors, genre, rapport, or social relationships affect turn-taking; other coordinative processes like engagement; and more broadly, various applications, opportunities, and challenges in this domain. While a significant proportion of the work presented focused on turn-taking in spoken language interaction, a number of other domains, for example, interactions and coordination with robots, were also prominently featured.

The symposium also featured two invited talks. The first talk, given by Jill Fain Lehman from Disney Research Pittsburgh, showcased her group's work over the past several years on developing language-based interaction systems and games for small groups of young children. Jill highlighted the difficulties of coordinating turns with groups of children, especially as the children begin having more fun and the situation becomes chaotic. In the second invited talk, Jeremy Frank from NASA Ames presented work from NASA's Autonomous Mission Operations project that investigates the impact of long communication time delays on the ability to conduct human spaceflight mission operations. The contrast between these two different ends of a spectrum for turn-taking — from very fast-paced, chaotic yet fun interactions with children, all the way to systems that support long communication delays in spaceflight operations, frames the diversity of approaches into the complex coordination problems that were discussed throughout the symposium.

In a breakout session, the symposium participants discussed the challenges shared between different research fields concerning turn-taking with highly interactive systems. They also expressed a desire for the development of common infrastructure, frameworks, and tools, as well as shared corpora in this space. Open questions were suggested, such as how might computer scientists engage more with social scientists, designers, and artists that might bring a different perspective and knowledge of turn-taking? What should be the agreed upon units of interaction in turn-taking, choosing among whole turns, utterances, fixed time slices, and so on? Can the community converge on a shared challenge problem for the field? The symposium participants finally expressed interest in attending future symposia or workshops within this space, possibly targeting specific conferences in relevant fields.

Sean Andrist (University of Wisconsin-Madison), Dan Bohus (Microsoft Research), Eric Horvitz (Microsoft Research), Bilge Mutlu (University of Wisconsin-Madison), and David Schlangen (Bielefeld University) served as cochairs of this symposium. This report was written by Sean Andrist and Dan Bohus. The papers of the symposium were published as AAAI Press Technical Report SS-15-07.

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Lalana Kagal is a principal research scientist at the Massachusetts Institute of Technology.

Takashi Kido is a research manager of Rikengenesis in Japan. He had been a visiting researcher at Stanford University.

Christopher Kiekintveld is an assistant professor in the Computer Science Department at the University of Texas at El Paso.

W. F. Lawless is a professor of mathematics at Paine College.

Andrew McCallum is professor in the College of Information and Computer Sciences at University of Massachusetts Amherst and director of UMass Amherst's Center for Data Science.

Hemant Purohit is a Ph.D. candidate at Wright State University.

Oshani Seneviratne is a recent Ph.D. graduate from the Massachusetts Institute of Technology.

Keiki Takadama is a professor of the University of Electro-Communications in Japan.

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