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Newsletter

PAVING THE HIGH-TECH INNOVATION HIGHWAY

BY KRISTINN R. THÓRISSON

Welcome to our fourth newsletter, and the first to contain a welcome note from the Managing Director. What a joy it is to write, because whatever questions you may have had about the goals and purposes of IIIM will be instantly answered by this issue's cover story: An innovative search-and-rescue system called NORRIS. NORRIS, already in use by the Icelandic Coast Guard, was developed by small but powerful startup Rögg ehf in collaboration with researchers at IIIM, who developed the algorithms and mathematics for the product. This first complete deployment of an IIIM deliverable in an industry-deployed product demonstrates a number of things: First, "research" does not have to mean "ivory tower"; second, an institution whose main mission is to bridge the gap between academia and industry does not have to steal time from academic duties (e.g. teaching) to get the job done – it can delve right in; and third, as opportunities to apply high-tech know-how can appear from anywhere within industry, at any time, providing an industry cornerstone in the form of a high-tech powerhouse that can make the difference between an idea that dies and an idea that saves lives. Lastly, of course, this shining example of a successful collaboration shows the difference that IIIM can make for the Icelandic high-tech industry. But this is of course just the beginning: Now we must address the bigger challenge of making everyone take notice of IIIM, and think of us as a mainstay in the Icelandic technology landscape – a powerful potential collaborator that can advance the state of the art. And maybe save lives. So, while the past three years have been extremely busy for us, the next three will be even more so.

COVER

On this issue's cover is a wireframe image of a helicopter as used in search missions by the Icelandic Coast Guard.

ILLUSTRATIONS

Our graphical theme this time is mechanisms.
For thousands of years artificial mechanisms were limited to physical connections, prime examples being mechanical watches. The internal combustion engine was achieved by throwing a bit of chemistry and electricity into the mix. Virtual mechanisms – algorithms running on processors – can now be found everywhere, including in our telephones, communication networks, washing machines, cameras, cars, buildings, airplanes, helicopters ... the list is very long.

ICELANDIC HIGHLANDS HIGH-TECH RESCUE

INTERVIEW WITH BALDVIN HANSSON

Baldvin Hansson has been working in the telecommunications industry for twenty-five years. During this time he has been actively involved in the design, building, and running of communication systems ranging from domestic telephone services to satellite-based telecommunications and packet-switched networks. He founded Rögg in 1993 and has spearheaded multiple software and hardware projects in the field of communications and information processing in his position as CEO and Chief Architect.

Among the many projects IIIM worked on in the past two years is a collaboration with Rögg ehf to develop a method for quickly and accurately pinpointing the location of lost hikers in the dangerous highlands of Iceland. Relying on a single helicopter outfitted with the new technology and the mobile phones carried by hikers, rescuers can track lost or injured hikers, even when they are unable to use the phone to call for help. The system, called NORRIS, promises to cut down on search time significantly, and could easily mean the difference between life and death in the Icelandic highlands.

NORRIS's improvement in search-and-rescue missions is mainly due to (1) its accuracy compared to current ways of tracking missing people, (2) its passive nature, which requires no action or even awareness of the search on the part of the missing person aside from having his or her phone powered on, coupled with (3) automated algorithms for calculating the position of the hiker – the component of the technology contributed by IIIM.

Baldvin Hansson, software architect at Rögg, answered some questions about the NORRIS system and collaboration with IIIM:

What triggered the idea for the system and motivated you turn the idea into a reality?

The system was conceived by Óskar H. Valtýsson, Head of Communications at the Icelandic National Power Company (Landsvirkjun), following a massive search that took place on an Icelandic glacier in November 2011. A young man had gotten lost up on a glacier and managed to call for help but was unable to give details of his location at the time. Watching the search unfold and realizing the number of people involved and the risk the rescuers put themselves at while conducting a thorough search in crevasses on the glacier, Mr. Valtýsson became convinced there had to be a way to use the GSM cell phone as a location beacon.
With 500 people involved in the search, about 300 of which were at the location and up to 80 up on the glacier at one point, it was obvious that improvement in aerial search capability would be very helpful.
While the search that triggered the system development was massive and rather large compared to average search missions, it is by no means unique. People get lost in the highlands all the time and it is not uncommon that people are carrying their cellphones, and thus have a great chance of being located if the NORRIS system is deployed fast enough.

Who are the people behind the product?

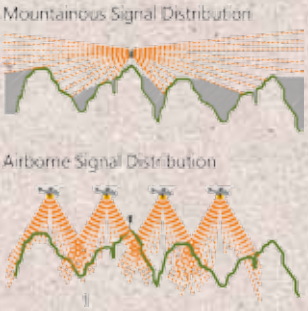
Mr. Valtýsson initially got the idea for the product. He then took his ideas to Rögg in Reykjavík and together we did the initial design work. Computer Scientist David Hansson and I, along with mathematicians from IIIM and various experts in the field of GSM, GPS, Radio Antennas and electronics, have partnered to make the system a reality.

Could you describe some of the challenges of building the system?

This is a complex system with a number of challenges. We have invented new ways to mount antennas on helicopters, ensure no interference with existing onboard systems, handle massive streams of real-time data flowing from system components during missions, perform calculations, and present this data to the crew. A big challenge has been to coordinate the efforts of everyone involved, from the antenna rig designers to cartographers, software engineers, user interface experts, pilots, and mission controllers, to take just a few examples. On the technical side, the main challenges have been applying solutions and systems from one discipline to solve problems in another. GPS mathematics are being applied to GSM data, GPS data is being used for mission planning, antenna design patterns are being applied to electronic circuit design, and data manipulation algorithms are used to manage and integrate information.

How has the system fared in testing on board a helicopter and how has the product been received by the Icelandic Coast Guard?

Field-testing aboard the Coast Guard Aerospatiale Super Puma AS-332L1 helicopters has been extremely successful. Major external system components like antenna and GSM transceivers have fared very well and the entire system has performed flawlessly on every mission. The Coast Guard has been very supportive from the beginning and valuable input



has been received from pilots and other crew members during the development and testing period.

Could you describe the significance of the collaboration with IIIM?

Having a talent pool like IIIM to draw from has been very helpful to this project. We were able to bring generalized problems to them and get specific solutions to choose from. IIIM has followed up very well and been supportive and open-minded in working out solutions to hurdles we have had to overcome along the way.

What does the future hold for the development of the system?

Currently, the system is being field-tested by the Icelandic Coast Guard. There is still room for a lot of improvement in both high-level user interface design and the development of additional system components and increased automation of various subsystems. We expect the system to be of interest to anyone responsible for patrolling or doing search and rescue work in vast wilderness or highland areas worldwide. It is our intention to continue development and gradually expand the usability of the system for the benefit of the general public. This spring Reykjavik University (RU) hosted the annual Open Day of IIIM and CADIA (RU's Center for Analysis and Design of Intelligent Agents). Researchers, students, and the public gathered to celebrate the fruitfulness of programs developed in the winter months and familiarize themselves with the developments within AI and related fields of research.

OPEN DAY
CADIA & IIIM

The open day serves as a gateway between academia and the public, encouraging questions and discussions about the newest research and development within the field of computer science and artificial intelligence.

This year's presentations were very diverse and interesting. Dr. Kristinn R. Thórisson introduced the RU-led, EU-funded HUMANOBS project that produced a radically new approach to machine learning. Rooted in cybernetics, this approach allows computer agents to learn complex tasks by observation, without the detailed information needed up-front in prior approaches.

Dr. Leifur Þór Leifsson presented the Laboratory for Unmanned Vehicles and its current projects.

Guests gained insight into Guðrún Fema Ólafsdóttir's project on simulated self-directed growth of human tissue. She aspires to create a new method for creating simulations of complex processes in the absence of a full mathematical model.

Dr. Jón Guðnason presented a project that focuses on using voice and other signals to characterize the emotional state of the speaker.

Dr. Kristinn R. Thórisson closed this years Open Day with a talk on Spatio-Semantic Knowledge for Intelligent Household Robots. He discussed how these robots will perceive and understand their environment, and could change the face of robotics.

All presentations can be viewed at
http://www.youtube.com/user/IIIMvideos

PUBLICATION OF SCIENTIFIC RESULTS: WHO PAYS?

Dr. Kristinn R. Thórisson is the Managing Director of IIIM. He has been researching artificial intelligence in academia and industry for over two decades. His research centers on artificial general intelligence, real-time interactive agents, and cognitive architectures. At MIT he pioneered new ideas in the area of multimodal communicative humanoids. Recent projects include a cognitive architecture for the humanoid robot ASIMO by Honda Motor Corporation and the constructivist-AI architecture AERA. He has taught advanced AI courses at Columbia University, KTH, and Reykjavik University, and consulted for NASA and British Telecom, among others. Kris has authored numerous scientific papers and sits on the editorial board of the Journal of Artificial General Intelligence and the LNCS Transactions on Computational Collective Intelligence. He is the co-founder of CADIA, Iceland's first AI lab. His work was recently awarded the Kurzweil Prize at the annual Artificial General Intelligence conference in Beijing (China).

Journal of Artificial General Intelligence Adopts Creative Commons License

Modern society has made a habit of constantly reminding us about the long arm of the law, whether it is through the millions of copyright notices printed on books, computer games, and photographs, or the inability to play songs purchased in one music service in more than one brand of playback device. While it makes sense to protect the income of independent artists, who typically are single individuals with only their family to back them – if even that, we should question the methods by which publishers continue to cling to the old methods when it comes to online distribution. In contrast to the arts, the scientific community is financially backed by a tradition of both public and private funding, typically with a short-term horizon in the latter case and a long-term in the former.

Scientific researchers supported by public funds are motivated to share their results with everyone, scientists and general public alike. After all, their work was funded by public money. And if everyone participates in this scheme – a large part of the scientific community already does – tremendous speedup of progress in knowledge acquisition results, since significant amounts of duplicated effort can be avoided. For this reason, fast and effective dissemination of scientific results is at the core of the progress of modern societies. It is therefore important to have the most efficient ways of disseminating scientific knowledge, especially when it comes to accessing the content of scientific papers. Access to the writings and results of scientists is therefore of enormous importance to society. Some would go so far as to say that such access should be direct, free, and without any limitations except that of preventing abuse or distortion of an author's original version.

Science is by nature a conservative trade, and the traditions of scientific knowledge dissemination date back quite a few centuries. As of now, electronic distribution methods strongly reflect the printing revolution, which harbors not only a paper-based method at its core but also a whole network of human organizations that, to a large extent, affect how such work is authored, reviewed, edited, and ultimately published. Of central concern in the modern Google-powered online information exchange, where distribution of scientific papers costs virtually nothing and, compared to the old methods of shipping books, takes very little time, is this question: Who pays for the publication of scientific material? Some obvious candidates are the consumer, the publisher, the author, and the institution where the reported research was conducted.

We will not answer that question in detail here, but in our view there should be no cost to the consumer of publicly-funded research results. The cost of publication should simply be considered part of the cost of research, and thus already paid for. Larger works, such as books summarizing research results on a particular subject over, say, a decade, would of course still be needed, and the cost of such work may require the consumer to pay a normal fee, as is now. But intermediate results from a two-million Euro research project, for example, from which many as fifty papers may result, should subsume the cost of writing up the results, printing the PDF, and posting it online in an appropriate forum. As peer-reviewing and editing of smaller scientific research papers (10-30 pages) is already done on a volunteer basis, this is not a significant change to present academic activities.

One part of the publication process is finding the right license for the work. The typical copyright notice that we are familiar with in the West gives full publication rights to the author, but for most scientific publications the authors waive these rights, giving them to the publisher instead. Why this should be the case is a bit of a conundrum – after all, if the public has already paid for the work, and these publications are the main, possibly only, record of the work, why should the publishers of that work get the complete and full rights to it?

Fortunately, not everyone is this draconian in their approach. We are particularly fond of the Creative Commons (CC) licenses. In a black-and-white world of total ownership, CC licenses bring some shades of gray, allowing, for example, an author to waive some, or even all, of their rights to their various works. In 2012 the Journal of Artificial General Intelligence (JAGI) took our advice and adopted a Creative Commons license for published articles. The publisher of JAGI, Versita, requires a fee from the author of $100. This would be paid by the research grant or the author's institution, but for researchers without grants, a waiver of the fee can be requested. Under the chosen CC license chosen by JAGI, anyone is free to copy and distribute the works, and to remix it, as long as they clearly attribute the work to its authors.

This is how we think the future of scientific publishing is going to be. We are very happy to see that some are already taking steps in this direction, and look forward to a world where publicly-funded research is the norm.

IIIM DIRECTOR AND COLLABORATORS AWARDED KURZWEIL PRIZE

For the second consecutive year IIIM Managing Director Kristinn R. Thórisson and Eric Nivel have received the prestigious Kurzweil Award, this time for their work with their collaborators Bas R. Steunebrink, Jan Koutník, and Jürgen Schmidhuber, researchers at IDSIA in Switzerland, one of Europe's most regarded AI research laboratories. Their prize-fetching paper "Resource-Bounded Machines are motivated to be Effective, Efficient, and Curious" is part of the result of a three-year HUMANOBS project, which was sponsored by the 7th European Community Framework Programme.

The motivation for the work was to develop a new type of self-programming artificial intelligence that can achieve greater levels of autonomy than any prior such system to date. A necessary function of any system that learns effectively and efficiently in an uncertain world, argue Thórisson and his collaborators, is *curiosity*. Curiosity drives the search for knowledge: Systems with comprehensive artificial intelligence driven by curiosity can grow to learn faster, make better use of available computing resources, and ensure that the knowledge the system has acquired is complete and trustworthy. Thórisson and Nivel hope that their paper will lead more researchers in the direction of their new *constructivist* approach to building AI systems, one that they believe may likely result in a "new breed" of artificial thinking machines that break with AI's current direction, highlighting the principles needed to achieve the field's ultimate goal of human-level machine intelligence – and perhaps beyond.

ERIC NIVEL ON KURZWEIL AWARD

How do you think this paper contributed to the overall goals of AI?

I believe it raised the attention of the community on the engineering side of AI. You know, more often than not, intelligence is characterized using a list of abstract, anthropomorphic capabilities – being "responsive", achieving "understanding", being "creative", and the like.
Basically what this paper shows is that some of these behaviors actually are an engineering necessity. These behaviors help systems to adapt and improve against adversity – curiosity for example stems from the necessity to know more in order to perform better, compression (and therefore understanding) stems from the urge to use less knowledge to react faster using less power and so on. I think this paper sheds a rather unusual, hopefully stimulating, light on the problem of establishing principles for the design of AI systems.

Eric Nivel
Affiliate Researcher, IIIM
Eric is a senior R&D engineer at Reykjavik University's Center for Analysis & Design of Intelligent Agents (CADIA). Eric's wide range of technical expertise includes evolutionary computing and architectures for autonomous systems to real time distributed systems and high-performance computing. He was the lead software engineer at Holografika in Hungary, where he designed the software for a realtime hologram system, and participated in various related FP6 projects for which he coordinated software engineering.
Eric successfully led the HUMANOBS FP7 project with Kristinn R. Thórisson.

For more information on HUMANOBS project
http://humanobs.org

Do you plan on going into more depth with this topic?

There is sometimes a tendency in AI to build systems starting from a list of required. Then these are broken down into more detail and in time we end up with a collection of ad-hoc parts that may perform as intended, but no more: they are generally not robust to change, they just can't adapt to novelty or invent new behaviors. In contrast, what we try to do in this new approach is focus the design on adaptation, including "how to keep performing when things go wrong". But, this research is just a part of a larger endeavor, which is concerned with establishing general principles for practical autonomous systems, so, as you can imagine, there is still a lot on our plate.

How do you think that some of the points in the paper can be practically applied?

This research, resulting from experiments in the HUMANOBS project, is directly anchored to a practical cognitive architecture which will lead to significant improvements in its cognitive capabilities. Besides this practical development, I think that the main impact of the paper could be to re-center the focus of AI on the principles and pragmatics of intelligent systems, I hope this will help in designing better systems, systems that are more realistic and more efficient.

What are you currently working on?

I'm currently augmenting our system with mechanisms that we believe can support curiosity, reasoning by analogy, and the like. The next version of AERA will be good enough to support academic research for at least 5 more years. We have already shown that the system can be used as a basis for new extensions, as two our award-winning papers on attention and curiosity hint at, and we are convinced that this work will enable significant steps towards artificial *general* intelligence. We are looking forward to having more people on board that can work with us using the new version of the software – which we plan to release as open-source later this year.

RECENT PUBLICATIONS & TECH REPORTS

Thórisson, K. R. (2013). Reductio ad Absurdum: On Oversimplification in Computer Science and its Pernicious Effect on Artificial Intelligence Research. In K-U Kühnberger, S. Rudolph & P. Wang (eds.), Proceedings of Artificial General Intelligence (AGI-13), Formal MAGIC – Workshop on formalization in artificial intelligence, Beijing, China, July 31st.

Nivel, E. & K. R. Thórisson (2013). Towards a Programming Paradigm for Control Systems With High Levels of Existential Autonomy. In K-U Kühnberger, S. Rudolph & P. Wang (eds.), Proceedings of Artificial General Intelligence (AGI-13), 78-87, Beijing, China.

Steunebrink, B. R., J. Koutnik, K. R. Thórisson, E. Nivel & J. Schmidhuber (2013). Resource-Bounded Machines are Motivated to be Efficient, Effective, and Curious. In K-U Kühnberger, S. Rudolph & P. Wang (eds.), Proceedings of Artificial General Intelligence (AGI-13), 119-129, Beijing, China. ***Recipient of the Kurzweil Prize for Best AGI Idea.***

Helgason, H. P., K. R. Thórisson, E. Nivel & P. Wang (2013). Predictive Generative Heuristics for Decision-Making in Real-World Environments. In K-U Kühnberger, S. Rudolph & P. Wang (eds.), Proceedings of Artificial General Intelligence (AGI-13), 50-59, Beijing, China.

Jonsdottir, G.R., & K. R. Thórisson (2013). A Distributed Architecture for Real-time Dialogue and On-task Learning of Efficient Co-operative Turn-taking. In M. Rojc and N. Campbell (eds.), Speech, Gaze and Affect.

Garrett, D. (2013). Tunable Instance Generation for Many-Task Reinforcement Learning. IIIM Technical Report IIIMTR-2013-09-001.

CONTACT

IIIM is located on the 2nd floor of Reykjavik University's new millennium building in Nautholsvik, within unique outdoors areas and near the country's only artificial beach.

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Rannsóknir Vitvélastonfunar eru að miklu leyti knúnar áfram af þörfum iðnaðarins og niðurstöðurnar hafa nýtingarmöguleika á mörgum sviðum, s.s. framleiðslu, tölvuleikjum, þjálfun með aðstoð tölvutækni, lífupplýsingafræði, orkukerfi, og stjórn vélmenna.

Vitvélastofnun leggur áherslu á að bæta gæði hugmynda, að auka flæði fólks og upplýsinga milli samstarfsaðila sinna, með það að markmiði að flýta fyrir árangri og hjálpa fyrirtækjum að sjá lengra inn í framtíðina, breikka sjóndeildarhring þeirra, og auka möguleika þeirra að koma hátæknivörum fyrr á markað.

IIIM THE ICELANDIC INSTITUTE FOR INTELLIGENT MACHINES

The Icelandic Institute for Intelligent Machines (IIIM) is a non-profit research institute that catalyzes innovation through a focused exchange of ideas, people, projects, and intellectual property. Through close affiliation with Iceland's strongest technological academic department, Reykjavik's School of Computer Science, we bridge the gap between industrial engineering needs and academic research results.

Our work is driven by the needs of industry, and has relevance to a wide range of application areas. To name just a few: Computer-based training, bioinformatics, computer games, energy systems, virtual and augmented realities, robotics, and information management systems.

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