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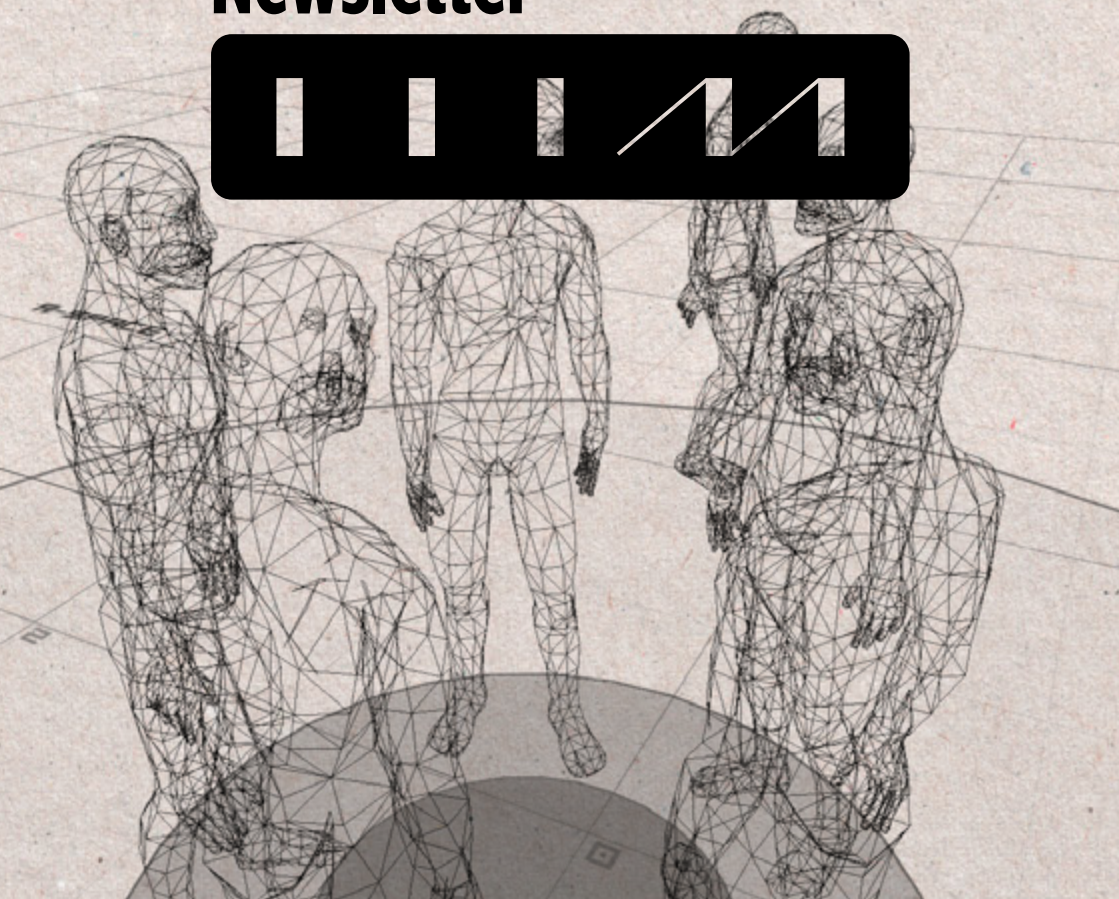
Newsletter



COVER

For this issue's cover, a wireframe image from Claudio Pedica's Impulsion project was chosen – avatars in conversation.

For last issue's cover we rendered a wireframe version of the HUMANOBS agent S1 – an artificial TV show host that can learn to conduct interviews with people by observing and imitating others. The HUMANOBS project, led by K. R. Thórisson and Eric Nivel, is funded by an FP7 grant from the European Union and is administered by Reykjavik University.

ILLUSTRATIONS

Inspired by Gudrun Fema's work on the human heart, the illustrations and quotes in this issue are inspired by the phenomenon of *emergence*. The journey from a single cell to a fully-formed heart is a good example of an emergent natural phenomenon, where a myriad of interacting forces, signals, and processes bring something into being that is clearly more than the "sum of its parts" – different from any of the underlying interaction rules. The most amazing result of such processes if of course when something that seems to fit a purpose, like a human heart, forms from processes that one is hard-pressed to imagine having any goals, intensions, or will.

ERRATA

In our last issue we incorrectly reported the European Union's FP7 as "FP6".

ON THE COLLABORATION OF IIIM AND CADIA
INTERVIEW WITH HANNES H. VILHJALMSSON

In the summer of 2006, **Dr. Hannes Högni Vilhjalmsson** joined Reykjavik University (R.U.), where he is doing research in the area of intelligent avatars and interactive virtual environments with an emphasis on social interaction and online collaboration. Before arriving at R.U., he spent three years as a research scientist at the University of Southern California's Information Sciences Institute (ISI), where he was a member of the Center for Advanced Research on Technology for Education (CARTE). In 2005 he co-founded Alelo Inc., a Los Angeles based start-up specializing in social training technologies, and remains at the company as a board member and technical advisor. He completed his Ph.D. in Media Arts and Sciences at the MIT Media Laboratory in 2003.

ru.is/~hannes

"Having briefly observed IIIM's efforts to bridge the gap between academic research and industrial applications, do you think that the Institute has opened up new possibilities for the application of the theoretical to the practical?"

Far too many research projects simply end up gathering dust on school library shelves after students complete their theses. The work may never reach the eyes of industries that could benefit greatly from the results. While the universities themselves are responsible for demonstrating industrial impact, having a dedicated institute like IIIM can make this process much more focused and effective.

"Is the institute making it easier to turn lab projects into practical, real world applications? How important is that and why?"

When a student has completed a research project, it has demonstrated value through innovation but it is typically still just a proof-of-concept or a custom-built laboratory experiment. The programming is not industrial grade and the software is not built for general use. This is where IIIM comes in.
The institute takes promising results into the realm of real-world applicability through industrial grade software engineering that targets specific external users. It is incredibly important to start addressing the end-users. Few things are more rewarding for a researcher than seeing people around the world picking up your project and giving you constructive feedback.

"Are there any specific benefits or downsides that you consider more important than others?"

The primary benefit, in my mind, is the ability to follow through with a project until it gets legs of its own - taking the project to a point where it has gained traction in the real world. This is never a trivial process and requires dedication and patience. It may be too soon to tell whether Impulsion will become a poster child for how CADIA and IIIM accomplish this together, and have the strong feeling that world domination is imminent. Seriously though, I'm impressed by how Impulsion is shaping up and look forward to seeing its progress.

IIIM'S IMPULSION TECHNOLOGY AIMS TO GIVE AVATARS' BEHAVIOR MORE REALISM

Claudio Pedica earned his M.Sc. degree jointly from Reykjavik University (R.U.) and Camerino University in 2009. He is a former research scientist from CADIA's AI Lab at R.U. Since 2008, his primary research interest has been in improving the believability of social behavior in interactive characters. He introduced the concept of territorial behaviors for autonomous agents, a novel approach grounded on sociological theories of human territoriality and face-to-face interaction. This approach can be viewed at the upcoming SIGGRAPH and has gained a following among some of the top companies in the industry, like CCP Games. Claudio has worked closely to implement his approach to the Carbon technology that powers EVE Online and other, soon to be released CCP titles.

Computer Generated [3D] Imagery (CGI) has become increasingly realistic. However, interactive creatures and beings such as player characters (avatars), or autonomous characters do not exhibit the same believability when they start to move and behave in their virtual surroundings. State of the art computer-generated character animation and control have yet to measure up to the visual quality standards of CGI. It is becoming increasingly obvious that more intelligent software is needed.

> **"No matter how compelling the graphics or thrilling the story, awkward character behavior often prevents player immersion"**

The loss of behavioral realism is often painfully noticeable in the computer-generated characters present in games and digital media. When seen in a still-frame, these characters appear almost photo-realistic. But once they begin moving, the realism disappears. Today's systems are unable to maintain realism for unnatural motion, or higher-level behavior (strange occurrences such as a character walking towards a random point, just to turn 90 degrees and walk straight to a door).

Other times, realism is degraded by overly-repetitive behavior (motion-capture recordings from the movements of human actors played over and over). As the gaming industry improves its storytelling capabilities, no matter how compelling the graphics or thrilling the story, awkward character behavior often prevents player immersion.

Middleware software tools for characters' artificial intelligence (AI) are already in use by many developers in the industry. These tools tend to solve problems of navigation, like how to get from A to B in a complex environment with buildings, mountains, forests, and more. Pathfinding and local avoidance empower virtual characters with an understanding of space.
Clever data structures, such as navmeshes, represent space as either occupied by solid objects or available free space. Behavioral programmers rely on those data structures to build autonomous characters whose reasoning is built on the degrees of freedom allowed by the environment, allowing characters to choose the best navigation option.

To achieve life-like character behavior, an understanding of space is insufficient without an understanding of context. For example, certain locations may have an intended usage that goes beyond their mere topological shape. Imagine a stage where a theatrical performance is taking place. Someone could walk across the stage, but usually would not: the space is meant for the actors to perform. This is known as affordance of space, a quality of the environment that allows individuals to carry out actions. An easy way to solve characters' behavioral issues would be to apply semantic tags to mark mark special locations of the environment. But what if the affordance of space changes dynamically?

Systems with emergent properties or emergent structures may appear to defy entropic principles and the second law of thermodynamics, because they form and increase order despite the lack of command and central control. This is possible because open systems can extract information and order out of the environment. – Wikipedia

DOES THE FUTURE OF AGI LIE IN COGNITIVE SYNERGY?

Dr. Ben Goertzel is an author and researcher in the field of artificial intelligence. His research work encompasses artificial general intelligence, natural language processing, cognitive science, data mining, machine learning, computational finance, bioinformatics, virtual worlds,gaming and other areas. He is Chief Scientist of the financial prediction firm Aidyia Holdings; Chairman of AI software company Novamente LLC and bioinformatics company Biomind LLC; Chairman of the Artificial General Intelligence Society and the OpenCog Foundation; Vice Chairman of futurist nonprofit Humanity+; Scientific Advisor of biopharma firm Genescient Corp.; Advisor to the Singularity University and Singularity Institute; Research Professor in the Fujian Key Lab for Brain-Like Intelligent Systems at Xiamen University, China; and general Chair of the Artificial General Intelligence conference series.

wp.goertzel.org

AI's original goal was to create human-like general intelligence in machines. Why did we only recently see progress?

Recent advances have put us in a far better position to approach this goal. Cognitive science and neuroscience have taught us what a cognitive architecture needs to look like to support roughly human-like general intelligence. Computer hardware has advanced to the point where we can build distributed systems containing large amounts of RAM and large numbers of processors that carry out complex tasks in real-time.

What do you think is the reason forw AI's lack of progress in achieving human-like intelligence?

Intelligence depends on the emergence of certain high-level structures and dynamics across a system's whole knowledge base. We have not discovered any one algorithm or approach that can yield the emergence of these structures. Achieving the emergence of these structures within a system formed by integrating a number of different AI algorithms and structures requires careful attention to how these algorithms and structures are integrated; so far this integration has not been done correctly.

How can we begin heading in the correct direction?

We can look to the human brain for answers. It is built with common components and arranged according to a sensible cognitive architecture. Its algorithms and structures have evolved to work closely together and given rise to overall systemic behaviors that characterize human-like general intelligence. This has created cognitive synergy: the fitting-together of different intelligent components into an appropriate cognitive architecture, in such a way that the components richly and dynamically support and assist each other, interrelating very closely in a similar manner to the components of the brain or body and thus giving rise to appropriate emergent structures and dynamics.

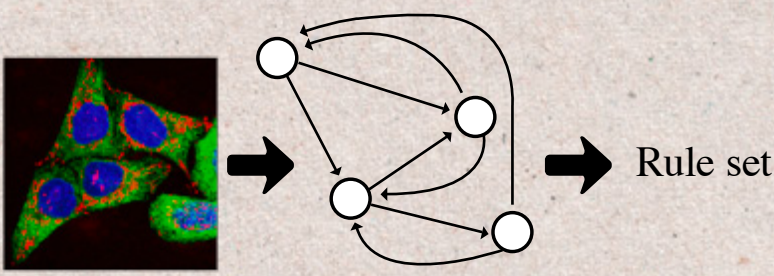
So, cognitive synergy is the key to advancing artificial general intelligence (AGI)?

Exactly. One of my conjectures regarding the engineering of AGI is that the cognitive synergy ensuing from integrating multiple symbolic and sub-symbolic learning and memory components, in an appropriate cognitive architecture and environment, can yield robust childlike intelligence. The reason this has not been explored much is its multi-leveled difficulty. AI algorithms and structures corresponding to different cognitive functions have been developed based on divergent theoretical principles, by disparate communities of researchers, and tuned for different tasks in different environments.

Does this mean that AGI can be achieved in the near future?

It's certainly possible. We believe that by making diverse components work together in a truly synergetic and cooperative way would produce human-level AGI from the technologies available today. This requires that everyone involved in AGI work together more closely—understanding each other's algorithms and theories, working together on common frameworks, and thinking about how our approaches and systems can synergize to create generally intelligent thinking machines.

"The ability to reduce everything to simple fundamental laws does not imply the ability to start from those laws and reconstruct the universe.The constructionist hypothesis breaks down when confronted with the twin difficulties of scale and complexity. At each level of complexity entirely new properties appear. ... We can now see that the whole becomes not merely more, but very different from the sum of its parts." – P.W. Anderson, 1972



HOW TO: CREATE A SELF-ASSEMBLING HUMAN HEART TISSUE

Gudrun Fema Olafsdottir earned her B.Sc. in Mathematics from Reykjavik University in 2011, studying under the Aperio program. Her scientific interest is biology, mathematics, and computer science, and she is in the early stages of combining techniques from these fields to simulate neuromuscular heart-tissue.

Above: In systems biology Process Algebra and Finite State Machines (FSM) have been used for formal representations of biological systems. Biological cell signaling aids in the discovery of a proper ruleset for enabling individual components to better self-organize. We believe representing signals in this manner will eventually enable them to be converted for rulesets in simulation, convincingly mirroring nature's processes.

Consider how cells in the human body emerge: Complex shapes self-assemble into larger structures such as organs. These structures have functions, complex dependencies upon other similar components. Together these components can lead to even more complex behavior.

How are such "mindless" components able to self-assemble into elegant, functional forms of much greater complexity?

The answer to this question could revolutionize our understanding of the human body and other biological systems. At IIIM, Gudrun Fema Olafsdottir's research on computer simulations is attempting to mimic these biological processes by focusing on the development of the human heart.

Using virtual cells to simulate principles found in natural biological systems involves challenges such as pinpointing how simple components interact to form a stable, complex system. The research goal is to identify key rules of behavior that combine and govern the development of a human heart.

Anyone who uncovers how the principles of emergence enable cells to self-organize and form complex organs could revolutionize how we understand and heal the human body. In the long run, this kind of work can be extremely valuable; areas such as the detection and prevention of birth defects are just some of the applications. The nature and function of complex systems stands on the verge of biology, physics, mathematics, and molecular science. The areas of computer science and artificial intelligence are our most promising means of expanding our knowledge.

IIIM / CADIA OPEN DAY: SELECTED RESEARCH PROJECTS

Photo on right: The LivingShadows project by RU Aperio students **Gunnar Steinn Valgardsson** and **Hrafn Th. Thorisson** gives shadows a life of their own; projected on a wall that you may casually walk by, your shadow takes on a life of its own, interact with other shadows, and may even get into tiffs with shadows cast by non-existent entities.

This spring IIIM continued its annual tradition of Open Day, allowing anyone interested in the institute and field of AI to view the latest developments. This year's Open Day was held in collaboration with RU's Center for Analysis and Design of Intelligent Agents (CADIA), which is one of its closest collaborators making for very impressive and interesting presentations.

IIIM showcased some of its ongoing projects such as: Dr. Deon Garrett's "Machine Learning of Many Diverse Tasks", Dr. Jacky Mallett's "Testing Economic Theory", and "The Day My Shadow Left Me", a shadow wall projection presented by Gunnar Steinn Valgarðsson and Hrafn Thorri Thorisson.

The projects presented by IIIM's collaborators from CADIA included: "General Game Playing: Learning to Play" by Dr Yngvi Björnsson, "Ambient Assisted Living" by Dr. Hannes H. Vilhjálmsson, and "First Impressions in Human-Agents Encounters" by Angelo Cafaro.

IIIM Open Day is a great opportunity to meet researchers, find out more about projects and achievements, future developments, and collaboration opportunities. IIIM welcomes discussions with other specialists in the field of computer science and artificial intelligence.

All presentations can be viewed at
youtube.com/user/IIIMvideos/videos

IIIM SPONSORS AUTONOMOUS SUBMARINE PROJECT AT REYKJAVIK UNIVERSITY

One of the team members–IIIM Research Assistant Hamid Pourvatan–discusses the challenges the team faced:

In this competition there were several tasks that Freyja had to do to gain points to beat the opponents. A competition run would be, for instance, some gates and hedges that Freyja had to pass through without colliding into them and a couple of buoys that she had to bump into in some specific order defined on the very day of competition. One of the more challenging tasks was shooting torpedoes at a target and following passive sonar pings to find and pick up a gift box.

In January 2011 a group of sixteen students from the School of Science and Engineering and School of Computer Science at Reykjavik University began a course called Integrated Project. Unlike other classes, Integrated Project did not have a final exam. Instead students spent fifteen weeks working tirelessly to build and program an Autonomous Underwater Vehicle (AUV) for the 14th International Autonomous Underwater Vehicle Competition. The competition was hosted by the Association for Unmanned Vehicle Systems International (AUVSI) and the Office of Naval Research (ONR) and took place on July 12–17th in San Diego, California.

Reykjavik University's first team entered the AUV competition in 2010, and 2011's team used this experience as its edge. They stripped down the AUV from 2010, improving its design and software with help from the previous year's team. At the end of the spring semester, twelve students continued working on the AUV to prepare it for the competition. When the AUV was complete, it was dubbed Freyja, after the Norse goddess of love and fertility, in spirit of the competition's 2011 theme–love. Freyja's performance was impressive and Reykjavik University's team was awarded fourth place in the prestigious RoboSub competition.

This year's competition was held in San Diego, California on July 17–22nd. The top three teams this year were from Cornell University (USA), University of Florida (USA), and École de Technologie Supérieure (Canada).

More info

hamidp.com/Projects/Entries/2011/8/27_Freyja_an_Autonomous_Underwater_Vehicle.html

IIIM ORGANIZES SELF-PROGRAMMING WORKSHOP FOR AGI CONFERENCE AT GOOGLE HEADQUARTERS

On Thursday, August 4, 2011, Dr. Kristinn Thórisson and Dr. Deon Garrett of IIIM, along with Dr. Pei Wang of Temple University, organized a workshop on self-programming in AGI systems at the Fourth Conference on Artificial General Intelligence (AGI) held at Google headquarters in Mountain View, CA.

For a system to be considered AGI some form of self-programming is necessary, since such systems have to be able to learn whole new skill-sets from experience, and not simply improve performance on a single or a small set of pre-programmed tasks. Existing AI techniques can only achieve this partially and many problems remain unsolved. Given the special requirements of AGI, we need to compare and evaluate alternative answers to fundamental questions related to self-programming processes. The workshop organized by IIIM provided a platform for discussion, attracting researchers from across the world to address pressing problems in the field.

The conference generated several submissions, but only seven were selected for publication and presentation. The presentations covered general issues such as what distinction, if any, should be made between self-programming and more conventional ideas of learning (Goertzel), and the appropriate role of self-programming in the development of AGI system. Other papers focused on particular aspects or implementations of self-programming systems, such as the role of creativity (Leijnen), imitation (Hall), and program-space search (Skaba). The self-programming capabilities of several existing architectures were discussed, including BECCA, a general system for feature creation and general reinforcement learning (Rohrer); NARS, an AI system based on non-axiomatic reasoning (Wang); and a newly proposed system based on the idea of “emergent inference” (Pissanetzky). All the papers are available from the IIIM web site at www.iiim.is/agi-workshop-self-programming/, and Google has posted videos of the presentations as part of Google Tech Talk at: http://www.youtube.com/watch?v=SeJtWvjkerg

Hrafn Thórisson of IIIM also announced the launch of Mindmakers, a community portal and collaboration site for AGI researchers. At present, Mindmakers is beginning to work closely with the AGI community as part of the 2012 AGI Conference as well as the newly founded Journal of Artificial General Intelligence.

Defining structure and detecting the emergence of complexity in nature are inherently subjective, though essential, scientific activities. Despite the difficulties, these problems can be analysed in terms of how model-building observers infer from measurements the computational capabilities embedded in non-linear processes. – J.P. Crutchfield, 1994

RECENT PUBLICATIONS & TECH REPORTS

Olafsdottir, G.F. (2011). A Methodology for Simulating Biological Cell Systems with Cellular Automata: The Case of the Human Heart. IIIM Technical Report IIIMTR-2011-04-001.

Mallett, J. (2010). What are the Limits on Commercial Bank Lending? IIIM Technical Report IIIMTR-2010-09-001.

Wang, P. (2010). Four Basic Questions about Artificial Intelligence. IIIM Technical Report IIIMTR-2010-05-001.

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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