IIIM

Newsletter

of the Icelandic Institute for Intelligent Machines, Reykjavik

COVER

On this issue's cover is a screenshot from Aldin Dynamics' virtual reality game "Asunder".
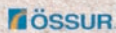
ILLUSTRATIONS

Our theme for illustrations in this issue comes from user interfaces of various kinds. Photos by KRTh.

Our industry collaborators include

Our research partners include

PAVING THE HIGH-TECH INNOVATION HIGHWAY
BY KRISTINN R. THÓRISSON

Welcome to our fifth IIIM Newsletter. It is not every month–or even year–that I get to write about a new medium. I remember my amazement in the late 80s when NASA Ames demonstrated one of the first virtual reality (VR) systems and Jaron Lanier made the headlines with VPL, a company intent on revolution with their Data Glove and immersive VR goggles.

So much has changed since then–yet so little, at last in the land of VR. VPL filed bankruptcy in 1990 and VR never flew into outer space. But now we may finally see the birth of this medium in formats accessible to the masses, spearheaded by Oculus, Google, and others. The impact–whether it happens now or in a few years–will be profound: It is not every decade that a brand new medium bursts onto the scene. Why do I think VR is revolutionary? It is the only medium that can (almost) fully immerse the senses, in a way that makes you truly feel like you are in a different place. This is the next step up from movies, and it's been over 100 years since the invention of cinema.

The very first IIIM spinoff, Aldin Dynamics ehf, lead by IIIM's Gunnar Valgardsson and Hrafn Thórisson, is at the forefront of defining how this new medium is harnessed. Their games Trial of the Rift Drifter and Asunder: Earthbound have raised eyebrows the world over (there are over 60,000 Oculus Rift developer kits already out there), they have been interviewed and featured on noteworthy news sites including GameWalking. com and the Guardian, and made Cymatic Bruce's 2013 Top 10 Best VR Experiences of the Year.

Aldin Dynamics is one of a few companies in the world truly poised to exploit and expand this new medium–and thus to define its meaning. As any high-tech medium with deep potential for expression, there is immense room for growth: The future is bound only by our own imaginations. In the creativity department the Aldin team is truly gifted. We are very proud of what they have accomplished so far and can't wait to see what they'll do next.

DESIGNING VIRTUAL REALITY: FOUNDERS OF ALDIN DYNAMICS

Gunnar Steinn Valgardsson is co-founder of Aldin Dynamics where his role has been leading product and technology development. His past work has focused on developing and managing projects within the fields of educational software, artificial intelligence (AI) and virtual environments. His work in AI received a nomination for the Presidential Innovation Award and has published multiple peer-reviewed papers at international conferences.

Hrafn Thorri Thórisson is co-founder of Aldin Dynamics and his responsibilities focus on business development, marketing and artistic direction. His past work includes being founder and President of the Icelandic Society for Intelligence Research and organizing the first AI Festival in Iceland. His award-winning research on creative AI systems has been published in books and peer-reviewed papers at numerous international conferences.

Aldin Dynamics, an Icelandic game studio founded in 2013, is already among a handful of leading international startups in virtual reality game development. Its first commercial virtual reality game Asunder: Earthbound, released last year, has become one of the most popular consumer VR games to date, named by IGN as one of the Ten Games that'll make you want an Oculus Rift, and listed among the Top 10 Best VR Experiences of the Year by popular community vote. Aldin introduces innovations and new approaches to VR game design, creating games specifically engineered for VR headsets to take full advantage of the medium. The game was also hand-picked by Facebook's Oculus VR to be featured on Oculus Share, their VR showcase platform, for two months straight.

"We want to explore as many approaches as possible for effective VR gameplay and powerful experiences," says Gunnar Steinn, "especially of interest are means to use artificial intelligence to help immerse players more deeply into story progression. Artificial intelligence, especially for characters and narrative, has added weight in VR and we expect social AI to serve an important role in future VR games."

"VR is a whole new medium, offering new opportunities reaching well beyond gaming."

"When you meet a non-player character (NPC) in VR your brain naturally considers it a living being within your own personal space. This means that when you physically look away from the character you still get a strong feeling of presence. On a regular screen, this just doesn't happen—once the player rotates himself from an NPC and it 'leaves' the screen-frame, he naturally loses interest in that character because it just isn't there any more."

THE INTERVIEW

What is the significance of having IIIM as a partner?

HTh: We developed and marketed one of the world's first consumer VR products, largely thanks to IIIM support. A focus of our partnership is developing novel AI software technologies for the VR medium. With AI poised to become key tech in the future of consumer VR, the collaborative effort can be highly valuable to both parties. We have new products brewing that are poised to really set their mark on the VR industry, and in future collaboration with IIIM we will be able to introduce truly groundbreaking technologies.

What innovations has Aldin introduced to VR?

> "Porting pre-existing games will never deliver a true VR experience– the nature of the medium is too transformative."

GS: Asunder immerses the player in a detail-rich environment, introducing novel gameplay mechanics for VR games. A gesture-recognition system allows players to communicate with in-game characters through natural gestures such as nodding and shaking their (physical) heads. We enable the NPCs to pay attention to where the player is looking in a natural way. If a player's attention starts to drift when someone is talking, for example, the NPCs can become mad and yell at you. These types of innovative interfaces simply didn't exist for the Oculus Rift until we introduced them, and they're an exciting frontier for social interaction in games that takes user-engagement and immersion to an entirely new level.

HTh: We discovered early on that it is crucial to design everything specifically as a VR experience. For instance, when designing the virtual environment in Asunder we paid a lot of attention to detail and found that a vast majority of our players really enjoyed taking in the atmosphere and discovering hidden design details.

How will consumer VR impact on society?

HTh: VR is a whole new medium, offering new opportunities reaching well beyond gaming; imagine VR for learning life-saving skills such as first aid—for example—that's something that we've been exploring in collaboration with IIIM. It's an incredibly powerful way for everyone to learn and play.

Chairman of the Board, Hlynur Halldórsson, LL.M. tries Aldin Dynamics' Asunder

Board Member Thórunn Sigfúsdóttir was impressed with the VR experience

GS: We look at virtual reality as a chance to reinvent the gaming experience. Its potential is almost limitless. Porting pre-existing games will never deliver a true VR experience —the nature of the medium is too transformative. It's clear that game design needs to be rethought specifically for VR to take full advantage of the technology. This offers a great opportunity, especially for new startups, to invent entirely new gaming genres.

What lies in Aldin Dynamics' future?

"There are exciting investment opportunities surfacing for VR software."

GS: The computer industry is on the verge of adopting a new medium in the form of consumer virtual reality and consumers will demand a lineup of great games. Our company is creating a new product that takes full advantage of VR and showcases what makes VR games unique and attractive. Currently we're seeking full-financing to bring this product to market. There are exciting investment opportunities surfacing for VR software and those who jump in at this early stage will gain major advantage.

HTh: Our long-term vision for the Aldin team centers on designing games the likes of which the world has never seen. Above all, they should be deeply meaningful and unique. The more we understand the opportunities that VR offers—and we have barely begun scratching the surface of what's possible— the deeper we can go. We have a new relatively large-scale product in the works that has potential not only to break new ground for the consumer but possibly even to strongly influence virtual reality software development and set new industry standards. Along with the development of this new product we are hard at work on devising ways to get it funded.
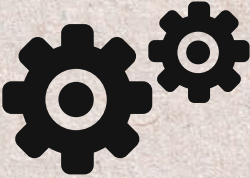
MULTI-OBJECTIVE MACHINE LEARNING

Dr. Deon Garrett is a Sr. Research Scientist at the Icelandic Institute for Intelligent Machines and an Affiliated Researcher in the School of Computer Science at Reykjavik University since 2010. He holds a PhD in Computer Science from the University of Memphis, and currently works in machine learning and optimization, with a particular focus on multi-objective optimization and multi-task learning including multi-armed robot coordination, optimization of wind turbine design, and applying machine learning methods to solve various industry problems. He has served on the program committee for more than twenty conferences and journals in the fields of machine learning and optimization.

IIIM has a strong focus on artificial intelligence in all its forms, from solving basic industry challenges to the problem of building an artificial general intelligence (AGI). The term "machine learning" is typically used to describe a subfield of AI whose focus is on improving the ability of machines to solve specific, well-defined problems. Many of the recent success stories in AI have been of this kind.

A well-known success story of machine learning is the problem of recognizing hand-written digits, which by now been solved by statistical machine learning techniques such as neural networks. Recognition of handwriting had significant commercial value in domains such as shipping, where users generally hand-write addresses onto shipping labels that need to be readable by a machine. Through machine learning methods, a computer can be trained to capture an image of a shipping label from a camera, and reliably convert the hand-written postal code into the correct digits, regardless of the size of the written digits, the orientation of the label, and other complicating factors. However, once the problem was solved, the resulting computer program was no closer to solving other problems—even very closely related problems such as recognizing letters—than any other approach. In current state-of-the-art machine learning methods each specific problem needs to be considered independently, and very little, if any, knowledge gained in addressing one problem can be transferred to solving a new one.

This is a significant issue in applying machine learning to the problem of developing generally intelligent systems (AGI). In recent years, machine learning researchers have begun to work on addressing this problem through a couple of approaches. Transfer learning refers to the process of learning to solve one problem and then, when faced with a similar problem, exploiting the obtained knowledge and skill from the prior learning phase to solve the new problem more quickly and accurately than possible if starting with the new problem from scratch. A slightly more general idea is that of multi-task learning. In multi-task learning, we do not assume that the tasks are presented sequentially, so the machine may not have already learned the first task prior to encountering the second task, and, in fact, the tasks may not even be related at all.

IIIM is working on the general multi-task learning problem with a particular focus on reinforcement learning. In reinforcement learning, there is no "tutor" giving the machine detailed feedback at every step. Instead, the machine has to learn based on indirect feedback from the environment it operates in. For instance, if the machine is to learn to drive a car, the supervised learning approach (e.g. used in the digit-recognition problem)

would be that the machine makes decisions, and for each action it takes, a human tutor tells it not only whether the action was good, but also which action should have been taken in that situation. In reinforcement learning, the machine would get no such feedback. Instead, it would receive only a positive or negative reinforcement signal after particular events such as crashing the car, successfully reaching its destination, etc. From this indirect and often delayed feedback, the machine must learn to correctly operate the vehicle. In that sense, reinforcement learning is more challenging than supervised learning, but is also often more relevant to difficult problems in which no detailed knowledge of the correct answer already exists, which is certainly the case with many problems that humans routinely solve.

As part of a three-year grant funded by the EU Marie-Curie program, IIIM has been working to extend the reinforcement learning framework from the current standard of learning single, narrowly specified tasks to the case of learning in much more open-ended environments in which many skills need to be learned concurrently. Our approach is to develop learning algorithms that are able to, rather than choose and execute a single optimal action at any stage of the process, recommend a range of actions to a higher-order decision engine, which could be part of an AGI system. In this view, the role of the low-level learning component is to learn which actions conceivably help to attain any of the desired goals, and then feed this information to another part of the system responsible for balancing between the often conflicting goals we set for the system.

This research area is very new and prior work has been very preliminary in nature, generally using relatively simplistic test domains. One of the first contributions we have made is the development of a method for generating benchmarking and test scenarios to evaluate and compare the performance of multi-task learning algorithms. This tool has been developed and released as open-source software to the research community, and is documented in a recently submitted paper to the European Conference on Artificial Intelligence. The technology is already being used for internal algorithm development and is currently being considered to be made part of our collaboration with one of our Icelandic industry partners. In the coming

months we will continue to leverage our expertise in these issues, with a drive towards algorithms that can deal with many more concurrent tasks than available methods, and to integrate these into larger and more flexible AI systems. Significant progress on this front will mean more autonomous systems that require less direct human involvement and that could continue to improve well after they are deployed.

TOBBI KRISTJÁNS & STEPHEN HAWKING:
AGI - OUR LAST INVENTION?

Thorbjörn Kristjánsson is a IIIM intern, he earned his BA in Philosophy from the University of Iceland in 2011. During his time as an undergraduate he worked on two projects funded by the Icelandic Student Innovation Fund, the first one focused on using causal loop diagrams to analyze the economic collapse in 2008 and the second focused on ethical challenges concerning cosmetic surgeries. Thorbjörn is currently an MA student in Philosophy at Aarhus University, where he is working on his thesis which focuses on analyzing the impact of modern and near-future mechanical warfare on just war theory. He is a member of the Nordic War Network, an institute affiliated with Stockholm University, which brings together scholars in Northern Europe working on aspects of the ethics of war, and Pensor – a transdisciplinary research group on social robotics.

Thorbjörn Kristjánsson, philosopher.

"Real AI could be the most amazing thing humanity has ever accomplished"

On last February 17th the Icelandic newspaper DV published an interview with IIIM intern Thorbjorn (Tobbi) Kristjansson about his work at IIIM. The heading read "Could mean the end of humanity if we don't play it right" and in it Tobbi describes his concerns about the future uses and abuses of AI. Two months later (May 1st) the famed scientist Stephen Hawking authored an article in The Independent asking us whether we are taking AI seriously enough. His article was triggered by the movie Transcendence, in which Johnny Depp plays an AI researcher intent on creating "Real AI", also referred to as artificial general intelligence (AGI) – machines that can really think and rival humans in their intelligence. Echoing the dystopian title given to Tobbi's interview, Hawking warns that while real AI could be the most amazing thing humanity has ever accomplished, "it could also be the last."

Stephen Hawking, physicist.

Like Hawking, IIIM takes AI seriously and wants to do something about it. So last summer IIIM hired Mr. Kristjansson to do a study of the various risks of current and future AI, under the guidance of the IIIM's Managing Director Dr. Kristinn R. Thórisson and his supervisor at Aarhus University, Dr. Morten Dige. The work, which earlier this year was one of a few projects out of over 200 considered for a nomination to the Icelandic president's Student Innovation Award, is now providing an important backdrop for IIIM's new Ethics Policy Regarding Funding Sources, expected to take effect later this year.

Ethics and AI: What is the connection?

AI technology is already found in telecommunications, digital photography, computer games, and robots that perform various functions such as control, baggage screening, factory production, etc.–all very benign uses. Recent years have seen rapid development of AI for military use, including new weapons and various robotic technologies for war. Thorbjorn's study focuses on ethical issues in the development and use of AI for this purpose, especially in light of future developments and the potential for its misuse in our society. Moreover, the aim of his work is to identify and analyze risk factors associated with the rapid advancements on this front, risk factors that range from surveillance and data mining and its impact on privacy to its potential catastrophic use in cyberwarfare–a new and relatively uncharted domain of warfare. Many ethical questions can be raised in the context of such uses of AI, as well as its application to espionage and surveillance, automation of energy networks, and deployment of robots in numerous new areas of industry.

Tobbi Kristjáns' project was one of a few considered for the annual Icelandic president's Student Innovation Award

VITVÉLASTOFNUN ÍSLANDS SES

Vitvélastofnun Íslands ses er sjálfseignarstofnun með það markmið að brúa milli iðnaðar og háskólarannsókna og að hraða nýsköpun í hátækniiðnaði á Íslandi. Náið samstarf stofnunarinnar við Tölvunarfræðideild Háskólans í Reykjavík tryggir tengsl við fremstu vísindamenn landsins á helstu tæknisviðum svo sem stærðfræði, fræðilegri tölvunarfræði, verkfræði og gervigreind.

Rannsóknir Vitvélastofnunar 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, auka samskipti og flæði 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 nonprofit 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 University'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, artificial intelligence, machine learning, and data manipulation. IIIM's software tools, methods, and systems help companies see further into the future, integrate high technology into their product lines, and produce more advanced products faster.

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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