Volume 2 // 2016

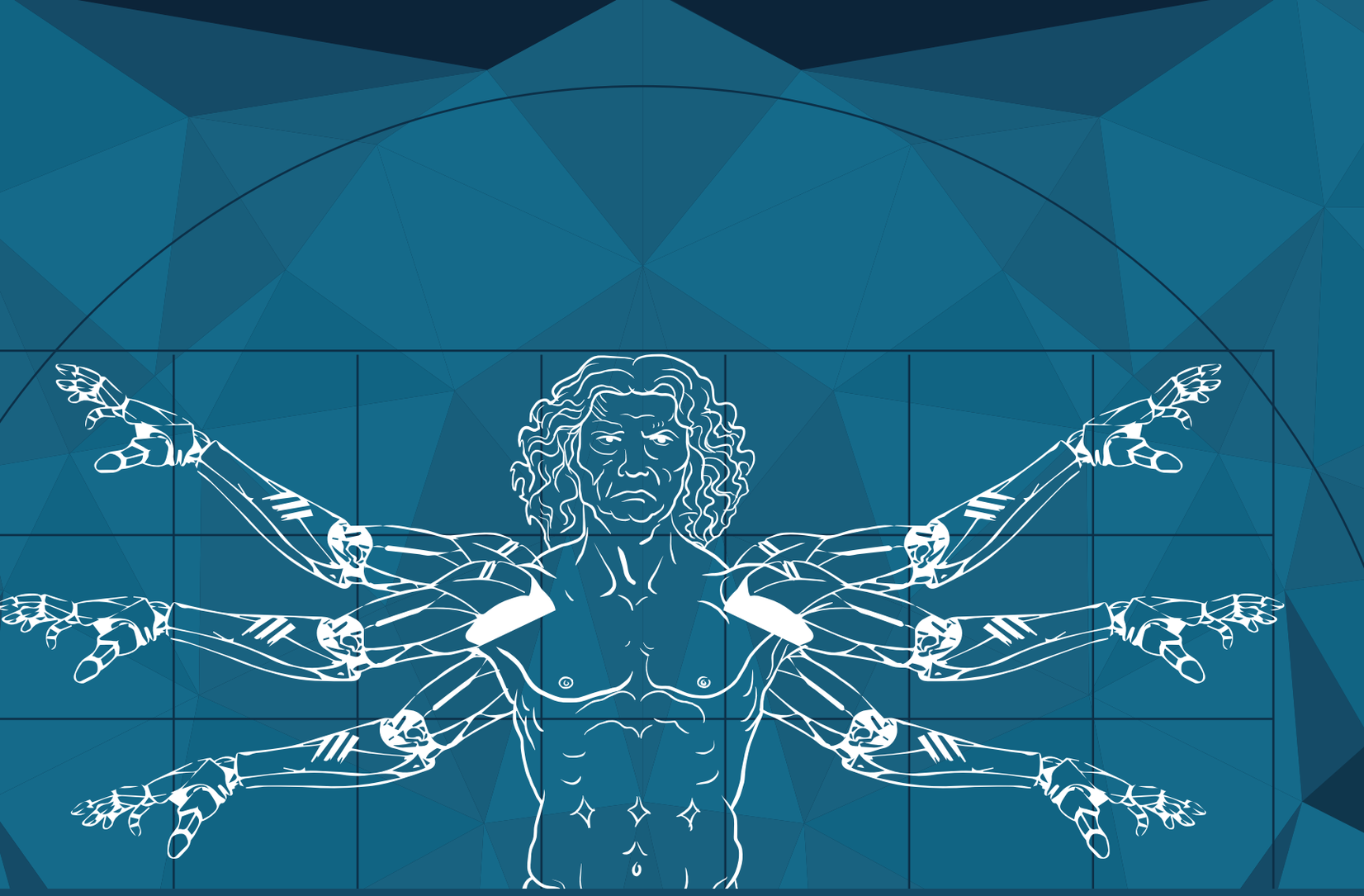
America's finest wartime commander

COGNITIVE TIMES

General John R. Allen (Retd.)

LEADING THE AI REVOLUTION

The cognitive movement has a new Commander



HUMAN INTELLIGENCE @ MACHINE SCALE

CONTENTS

Hello AI World:

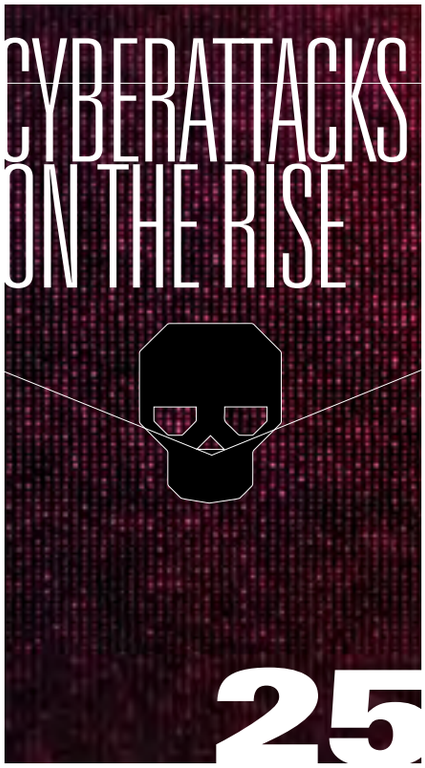
$$\left(P + a\left(\frac{N}{V}\right)^2\right)(V - bN) =$$

re a and b are empirical constants that de
on. Now, for sufficiently high values of T
naved. But it should be easy enough to see
get behavior that is somewhat crazy. In p
d T, and sufficiently low T, you can find so

when you think of it – increasing the vol
e! No stable gas can satisfy these conditions.
e Van der Walls equation is junk (and it's
proximation), but what it really means is s
der Waals equation of state is telling you

ALGORITHMIC THINKING

WHICH CAME FIRST:



INFOSPARK

AI SPORTS

AI'S COMING OF AGE

BY AMIR HUSAIN

One of the questions I get asked most often is whether I believe Artificial General Intelligence (AGI) –synthetic, computerized intelligence that will rival human capacity – will ever come about. In one sense, I can't definitely point to the specific ways in which this will happen. But looked at another way, there are so many possible ways to get there; direct construction of algorithms, reverse engineering the brain and implementing what is known as "whole brain emulation", using sophisticated genetic algorithms and deep learning to evolve the right type of brain. Approaches abound. And along each path, significant progress is being made. IBM's Synapse chip is implementing a very different kind of processor, one that shuns traditional von Neumann architecture in favor of a biologically inspired model. At the same time, Henry Markram's billion euro+ project hums along in the EU attempting to develop technologies that will allow us to map the mind.

When Nick Bostrom, researching for his book, "Superintelligence" conducted a poll of AI researchers, he found that a substantial percentage believed that general intelligence would be achieved this century. 30, 40 or 50 years out might seem to be a long road ahead to the commercial sector, or the child waiting for his iPhone to do more, but it is the blink of an eye in the history of nation states. If there is a broad consensus that very capable artificial intelligence is around the proverbial corner, much needs to be done from a policy, readiness and planning perspective to exploit the opportunities and avoid the pitfalls. There are opportunities already… we don't have to wait for the advent of Artificial General Intelligence to benefit from machine learning and machine intelligence. Hedge funds are already using AI to find patterns humans can't see, Industrial companies are using these algorithms to forecast failures that seem counterintuitive to a human being. And aviation companies are employing multiple forms of Artificial Intelligence to not only detect problems but also prescribe solutions.

The cyber security realm is another key area when it comes to the potential relevance of AI. The reality is that crude AI technology, bots and automated systems are already being used to generate huge volumes of attacks. The strategy is to befuddle, confuse and overwhelm. That's if humans are left holding the line on the other end. The only true counter to AI is even smarter AI, and that certainly is the direction applications of AI in Cybersecurity are taking.

"THERE ARE SO MANY POSSIBLE WAYS TO GET [TO HUMAN-LEVEL AI]. AND ALONG EACH PATH, SIGNIFICANT PROGRESS IS BEING MADE."

Our cover story in this edition is the appointment of one of the nation's greatest Generals, perhaps the most respected warfighter in Washington D.C., to the board of Artificial Intelligence company, SparkCognition. SparkCognition has been solving problems exactly like the ones described above, and has now accumulated a broad list of very large customers who are working with the company to find deeper and deeper applications for the "virtual minds" SparkCognition builds. General Allen's achievements and credentials are so substantial and impressive that we highly recommend you don't miss out on the cover story to be found later in these pages. We simply take note that when the nation's most experienced warrior, commander and strategist joins hands with a bleeding edge Artificial Intelligence company, one must keep a close eye on the spectacular outcomes that are expected. Welcome General Allen, to the world of Artificial Intelligence!

FROM ONE AUSTIN AI LEADER TO ANOTHER: A CONVERSATION W/ AMIR HUSAIN AND H.O. MAYCOTTE

[OF UMBEL]

Austin is quickly emerging as a hub of AI innovation. The city's history as a collaborative area for startups and young companies—as well as the presence of the University of Texas and numerous venture capitalists—have created a prime ecosystem for artificial intelligence innovation and entrepreneurship.

Artificial intelligence may seem like a foreign concept to some consumers, but most people already interact with it on a daily basis. It's at work in voice recognition and command programs such as Siri and Google Now, as well as in the aviation and energy industries.

One of these companies leading the charge in Austin is Umbel. Located in the heart of the city, with offices at the Seaholm development, Umbel is building the technology to harness the world's data, while respecting and consciously defending the data rights of all. They believe data should be the most valuable asset that a company owns. To that end, Umbel specializes in helping some of the most recognizable names in sports, media, entertainment, and the nonprofit sector aggregate customer data, gather insights, and drive revenue. In a nutshell, Umbel collects and aggregates customer data from many sources into one platform. Then it uses that data to create segments, gather insights, and see what makes specific audiences unique. And finally Umbel's insights are used to sell tickets, drive sponsorships, retain members, and more.

Umbel is led by Higinio "H.O." Maycotte. As his online profile describes him, H.O., the great-grandson of the Mexican General who shot off Pancho Villa's leg, embodies the spirit of a true revolutionary. His background is in starting up innovative companies from scratch, such as RateGenius, Flightlock (a travel safety company purchased by Control Risks), Finetooth (a contract management solution, now doing business as Mumboe), the Texas Tribune (a non-profit, nonpartisan public media organization), and now Umbel (a company focused on protecting Data Rights).

Our CEO, Amir Husain, reached out to H.O. to ask him a few questions about his work, his company, and the AI industry. And despite his ancestor's sharpshooting tendencies, he's one of the friendliest guys you'll ever meet!

Cognitive Times: Could you tell us a little bit about yourself?

H.O.: I am the CEO of Umbel and a die-hard entrepreneur. I live with a sense of urgency to accomplish as much as I can in the little time we have been given. I believe that man has now been transcended by the machine and that we now live in service of said machine. My ultimate goal in life is to die in service of this machine.

Cognitive Times: What do you see as key elements of Umbel's vision?

H.O.: Our Vision at Umbel is to develop the framework by which people, companies, governments and machines (of course) can value data like any other asset. Today's accounting practices have not yet caught up to modern times. You can put a brick on a balance sheet, but not a profile for one of your most valued customers. That will come to an end before long, and we will not only treat data like an asset, but it will be banked like our cash or any other financial instrument. Banks will evolve as depositories for data assets and will help us manage our portfolio of data to maximize its value.

Cognitive Times: How does Umbel use Artificial Intelligence technology to support these goals?

H.O.: Umbel sees itself as the supply chain to the AI world. We know that without instant access to all of the underlying data, neither the human nor the machine analyst can perform at their highest potential.

[UMBEL IS LED BY HIGINIO "H.O." MAYCOTTE. AS HIS ONLINE PROFILE DESCRIBES HIM, THE GREAT-GRANDSON OF THE MEXICAN GENERAL WHO SHOT OFF PANCHO VILLA'S LEG,]

Cognitive Times: Umbel organized a great AI panel at SXSW, and you personally had a key role in making that happen. What were the main conclusions from that discussion?

H.O.: That was a fascinating discussion and it is clear that real life decisions and responsibility are now something we can delegate to the machines. Many worry about the ramifications of relinquishing such control, but just like the panelists on stage, I believe that our lives will actually improve, not get worse.

> UMBEL SEES ITSELF AS THE SUPPLY CHAIN TO THE AI WORLD.

Cognitive Times: How do you personally see AI developing? Do you see it replacing human skills or augmenting them?

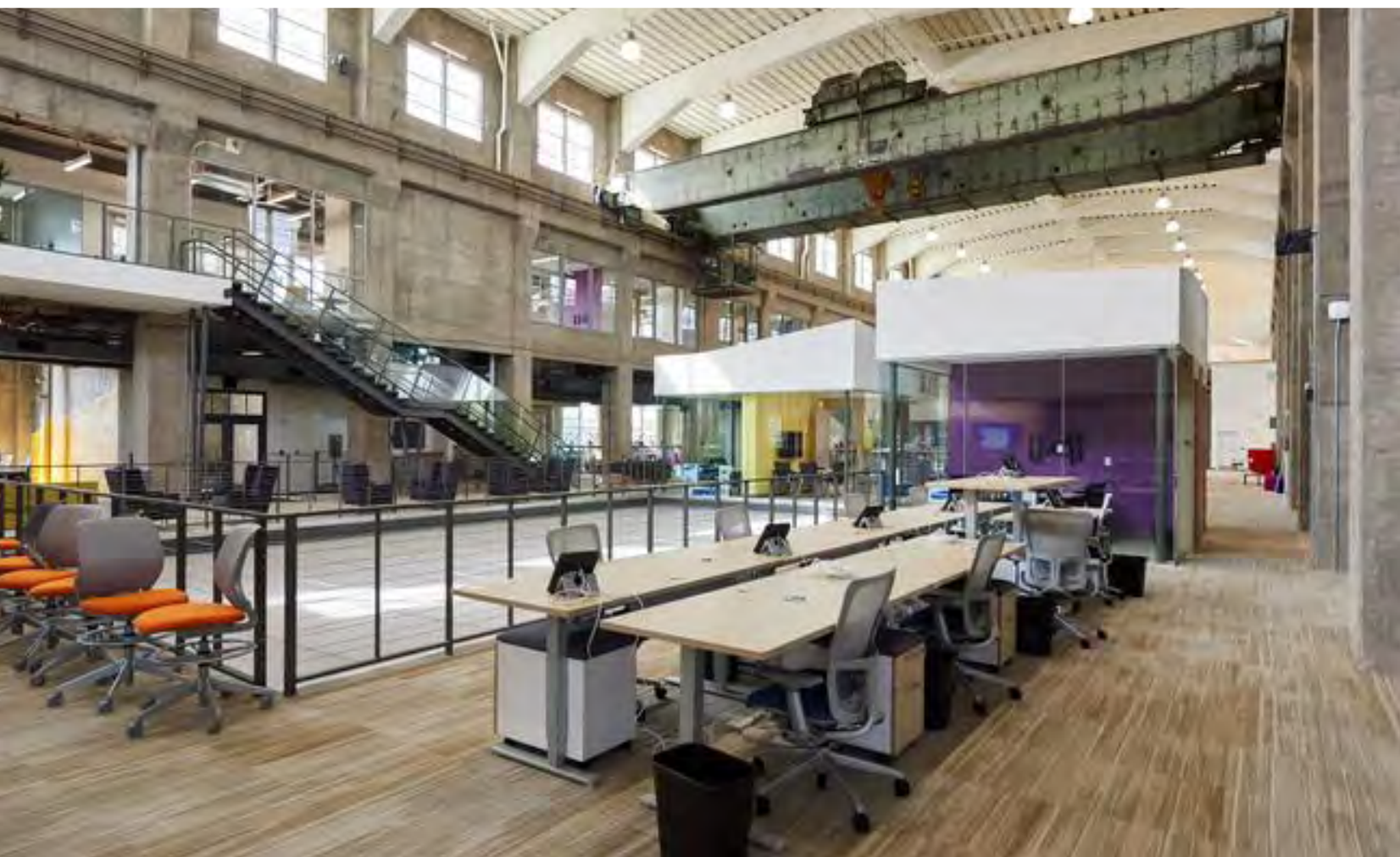
H.O.: As I said above, I feel that we (humans) have already been eclipsed in the hierarchy of life by the machines. However, being eclipsed does not mean that our life will get worse. I believe that we will be able to amplify and augment all of our senses in real time, at least giving us the perception that things are better. It will be fascinating to see how and how quickly the human mind evolves with its machine competition.

Cognitive Times: Given your marketing expertise, what are some of the tough problems you and your team face on a regular basis that could be addressed with smarter software?

H.O.: Augmenting the human experience in the context of sports, media and entertainment has tremendous potential. Humans are excitable animals, and as we recently saw in the NBA finals, there is a tremendous amount of passion, time, money and energy spent in this part of our life. Our goal is to make these experiences better by better connecting the audiences, players, teams, networks, and brands.

Cognitive Times: How do you see the AI ecosystem in Austin developing?

H.O.: Austin appears to be the perfect breeding ground for world changing AI. The creative class, the visionaries of the future and the raw technology labor force are coming together to build some of the world's most exciting improvements to AI. I look forward to being a valuable part of this ecosystem and seeing how it evolves over the next 5-10 years.



ARGUING THE CASE FOR MACHINE INTELLIGENCE. FROM SEA TO SHINING SEA.

Big Data Bootcamp

April 10-12th 2016

SparkCognition's Keith Moore, Senior Product Manager, and Louis Salin, Sr. Software Developer, facilitated an amazing training session to the brilliant attendees at this Austin conference.

Can Austin Rule the AI World? 2016 SXSW Panel

SXSW INTERACTIVE 2016 MARCH 11-15 AUSTIN, TX

WindPower 2016

Wind power has emerged as an essential new energy dynamic, especially in light of the U.S. EPA Clean Power Plan. WINDPOWER 2016 is the premier event in the wind industry. Modern energy demands modern solutions and everything that propels wind energy forward is assembled here.

AI has become a major force in technology and innovation, with innovators in Austin, TX leading the way

Artificial intelligence and machine learning look to be big growth sectors in the next decade. But don't let the techie term turn you off. Many believe that this is going to change the way everybody works, lives and plays, impacting the way consumers, patients, and employees interact with each other, their employers and other businesses. Some of the companies leading this charge are based in Central Texas. Find out why they believe Austin is the hub for all things cognitive. Why has this concentration developed here? What does Austin offer as a competitive advantage in this field that is not offered by other locations?

Panelists

Amir Husain SparkCognition Inc.
Manoj Saxena The Entrepreneurs' Fund
Akshay Sabhikhi CognitiveScale
Doreen Lorenzo Vidlet

AUSTIN UNDER FORTY

OTC (Offshore Technology Conference)

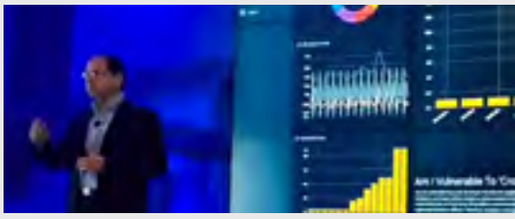
May 2nd-5th 2016

OTC is the largest event in the world for the oil and gas industry, where energy professionals meet to exchange ideas and opinions to advance scientific and technical knowledge for offshore resources and environmental matters.

In March SparkCognition's Usman Shuja was invited to discuss his recent theories and findings on the topic of Artificial Intelligence in sports at the 10th Annual MIT Sloan, Sports Analytics conference.

SparkCognition's Amir Husain was honored with the 2016 Austin Under 40 Technology and Sciences award! He joins other notable past winners like Stephen R. Delgado, Texas Engineering Solutions, and Chelseah McCullough, Texans for Economic Progress

World of **Watson**



SparkCognition Founder and CEO, Amir Husain, launches the latest version of SparkSecure at World of Watson 2015 in Brooklyn, New York.

SparkCognition Welcomes Pakistan Plan 9 Competition

May, 20th

Since its conception, Plan9 has incubated over 102 startups. A project of the Punjab Information Technology Board, Plan9 is Pakistan's Largest Tech Incubator that was launched in August 2012 to give budding entrepreneurs the opportunity to change their business dreams into a reality using technology as the key component. SparkCognition hosted a startup pitch competition for visiting Plan9 startups, in collaboration with the City of Austin and the US Dept of State.

America's Small Business Summit 2016

June 14

The Internet of Things (IoT), the next wave of technology, connects some 50 billion devices to the Internet. Internet-connected devices have the potential to unleash significant economic growth for small businesses and the data help businesses improve safety, reduce costs, and enhance productivity.

Panelists:

Matthew Eggers, Executive Director, Cybersecurity Policy, U.S. Chamber of Commerce
Susan Armstrong, Senior Vice President of Engineering, Qualcomm, Inc.
Snehal Antani, Chief Technology Officer, Splunk, Inc. (invited)

BUILDING ARTIFICIAL INTELLIGENCE MODELS WITH INTERNET-OF-THINGS DATA

BY ROGER KAY
CIO

You might ask what the difference is between most artificial intelligence (AI) companies and SparkCognition. Here it is: while at other firms, humans build models, SparkCognition puts them together with algorithms. Rather than roughing out one model and then doing a bunch of testing, SparkCognition continually tests and fits models to data accumulating in real time, an architecture that allows it to deal with big data.

But it's not primarily a big-data company. It's an AI company. Without foregone conclusions about what might be happening, SparkCognition algorithms keep probing for relationships and possible explanations without any a priori idea of what's going on.

This fantastic flexibility, along with the speed of computer technology, allows SparkCognition to come to conclusions fast enough for real-time intervention.

The company's early customers have mostly been infrastructure companies — oil and gas, pipeline and utility outfits — where sensors on expensive machinery generate a flood of data that SparkCognition interprets, looking for signs of potential failures, but its technology works equally well with cyber assets, which are also instrumented, but typically with virtual monitors like state bits and log files rather than with physical sensors. Thus, SparkCognition is an early player in analyzing the massive amount of data pouring off the Internet of Things (IoT).

For example, the SparkCognition approach helped pump-manufacturer FlowServe predict machine failures five days in advance, rather than in the two hours it had been able to achieve with human expertise. That's a 60-fold improvement. SparkCognition can perform such feats of prestidigitation not because it employs a staff of pump experts, but because of its algorithms, which don't care whether the data they're looking at represents financial fraud, pump failures or restaurant choices. As founder and CEO Amir Husain puts it, "We describe the universe with basic particles."

It is part of the company canon that a data-driven approach will outperform a domain expert — every time.

Netflix uses machine learning, but its recommendation engine was built by humans. They chose the model: age was the most important variable, then gender. Humans assigned weights to these and other variables, and humans continue to tweak them based on analysis of customer behavior and other feedback. But Netflix runs all the numbers through its man-made model. Amazon operates this way as well.

Now, SparkCognition has begun to approach the domains of virtual reality (VR) and its cousin augmented reality (AR). It is a blend of AI, AR/VR and the IoT that makes this development really interesting. With data captured from sensor platforms, SparkCognition generates security and management analytics and make predictions. But all this information can be overwhelming. However, it is a paradox of data density that the more data you have it's either more confusing — if its representation is, for example, text, tables or

raw numbers — or more clarifying — if it is represented visually. Visual data is clearer the more you have of it. Higher-resolution photos of distant galaxies are easier to understand than lower-resolution photos.

If a plant manager is looking at a refinery complex, there's a lot of detail there. But what if he or she was looking through AR glasses, actually seeing the plant, but also seeing failure warning data superimposed on the machinery, with the proper colors of severity — right where the potential failure is physically located. And what if he or she walked over to take a closer look and the data on the glasses changed to show more detail, controlled by the narrowing field of view as the manager approached.

This is the power of using the latest visualization techniques with IoT data. In an example of the VR side of the story, the Department of Defense is beginning to deploy VR worlds as cyber training tools, using AI to create red team vs. blue team simulations, where trainees end up being both defenders and attackers.

WHILE AT OTHER FIRMS, HUMANS BUILD MODELS, SPARKCOGNITION PUTS THEM TOGETHER WITH ALGORITHMS. RATHER THAN ROUGHING OUT ONE MODEL AND THEN DOING A BUNCH OF TESTING, SPARKCOGNITION CONTINUALLY TESTS AND FITS MODELS TO DATA ACCUMULATING IN REAL TIME.

As AI yields greater and greater insight from an ever-growing flood of data, the best representation of it will be visual, at the user's location in a mobile world. It's an exciting prospect, and SparkCognition is right at the front of it.

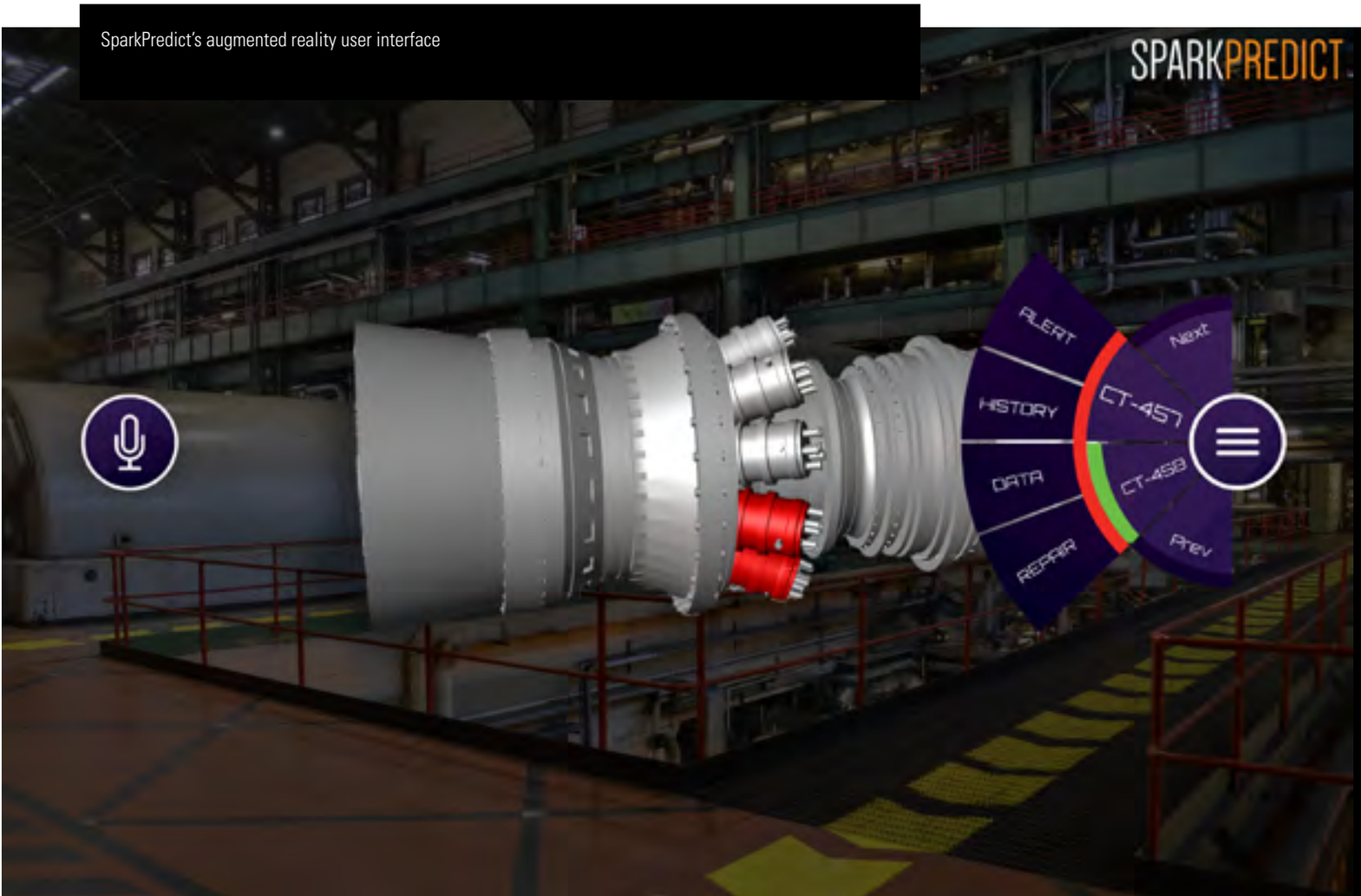
SEMI TRUTHS
By Roger Kay

This blog article reproduced with permission by CIO author Roger Kay.

@RogerKay

/RogerKay114

SparkPredict's augmented reality user interface



SPARKCOGNITION PRODUCTS WIN TWO EDISON AWARDS

OUR JUDGES RECOGNIZED SPARKCOGNITION AS A TRUE INNOVATOR OUT OF THE MANY PRODUCTS IN ITS CATEGORY," SAID FRANK BONAFILIA, EXECUTIVE DIRECTOR OF THE EDISON AWARDS.

SparkCognition recently announced that it had closed a $6M oversubscribed Series B funding round adding new investors CME Ventures, the venture capital arm of CME Group, and Verizon Ventures with participation from existing investors The Entrepreneurs' Fund (TEF) and Alameda Ventures. SparkCognition will use the funding to fuel its rapid growth as the company continues to gain major traction in the IoT and cyber security verticals.

"We are already well on our way to an AI-powered Industrial IoT Revolution – where cognitive systems will truly augment human capabilities, but at machine speed and big data scale," said Amir Husain, Founder and CEO of SparkCognition. "Our collaboration with CME Ventures and Verizon Ventures further validates the work we are doing at SparkCognition and speaks to the industry needs we are addressing within the Industrial IoT and cyber security markets."

SparkCognition has developed cutting-edge machine learning technology that models physical and virtual assets, continuously learns from data, and derives intelligent insights to secure and protect assets round the clock. In just under two years of launching its solution, the company has acquired dozens of major clients, including multiple Fortune 500 and Fortune 1,000 organizations. SparkCognition was awarded IBM's InnovateApp 2014, has been named a Gartner Cool Vendor and Austin's Hottest Start Up by SXSW in 2015 and the winner of Nokia's Global Open Innovation competition. The company was also selected as one of the top companies enabling the safety and security of the Industrial Internet by CIO Review.

"We are excited to have CME Ventures and Verizon Ventures joining as strategic investors," said Manoj Saxena, Chairman of the Board of SparkCognition and Former General Manager of IBM Watson. "The executive team at SparkCognition has done a remarkable job of acquiring an impressive list of clients, bringing on the best and the brightest, producing cutting edge IP, growing revenue, and building strong industry partnerships."

"CME Ventures is pleased to welcome SparkCognition as its latest investment given the potential for its technology to impact the markets of the future," said Rumi Morales, Executive Director, CME Ventures.

SparkCognition's technology is capable of harnessing real time infrastructure data and learning from it continuously, allowing for more accurate risk mitigation and prevention policies to intervene and avert disasters. The company's cybersecurity centered solution analyzes structured and unstructured data and natural language sources to identify potential attacks in the IoT environment. The uniqueness of the cognitive platform is resonated by the fact that it can continuously learn from data and derive automated insights to thwart any emerging issue.

"With the emergence of connected devices, cyber security becomes extremely important and solutions that can analyze structured and unstructured security data are needed," said Vijay Doradla, director at Verizon Ventures. "The uniqueness of SparkCognition's cognitive platform is clear. We look forward to working with this innovative group as their powerful technology propels IoT and cyber security forward."

WE ARE BUILDING THE FUTURE OF MACHINE LEARNING FOR IOT AND CYBER SECURITY.

SparkCognition, the world's first Cognitive Security Analytics company, was awarded United States Patent (US 9,292,675), titled "System and Method for Creating a Core Cognitive Fingerprint". This patent signifies a major advancement in machine learning methodology and is the 16th patent awarded to the company's Founder and CEO, Amir Husain. This patent is awarded on the heels of SparkCognition's recent $6 million major funding announcement by strategic investors Verizon Ventures and CME Ventures. Several industry accolades for innovation and leadership were also announced today.

"Austin is emerging as an innovation cluster for artificial intelligence and machine learning," said Bob Metcalfe, Professor of Innovation at The University of Texas at Austin and recipient of the National Medal of Technology. "SparkCognition is a leader in Austin's AI industry. The company continues to develop cutting edge machine learning technology for cyber security and the coming Internet of Things. SparkCognition continues to grow its business and has compiled an impressive list of customers and partners. This patent award is another major milestone in cognitive computing."

SparkCognition's patent was awarded for a system and method for creating a core cognitive fingerprint, which can be used to analyze many types of data and rapidly capture patterns representing the evolution of a system state to potentially respond with remedial action. The company has developed cutting-edge machine learning technology that models physical and virtual assets, continuously learns from data, and derives intelligent insights to secure and protect assets round the clock.

"From day one, we set out with the goal of revolutionizing the safety, security and reliability of the Industrial Internet. This recent patent award is further validation that we are accomplishing our goal, and we will continue to press forward aggressively," said Amir Husain, founder and CEO of SparkCognition. "We are building the future of machine learning for IoT and cyber security. Our team is driven to develop technology that makes a difference, and their focus and determination is producing great results."

In addition to the recent patent award, SparkCognition received two Edison awards for its cyber security solutions. Being recognized with an Edison Award has become one of the highest accolades a company can receive in the name of innovation and business. The ballot of nominees for the Edison Awards™ was judged by a panel of more than 3,000 leading business executives including past award winners, academics and leaders in the fields of product development, design, engineering, science and medical.

"Our judges recognized SparkCognition as a true innovator out of the many products in its category," said Frank Bonafilia, executive director of the Edison Awards.

SparkCognition's technology is capable of harnessing real time infrastructure data and learning from it continuously, allowing for more accurate risk mitigation and prevention policies to intervene and avert disasters. The company's cybersecurity-centered solution analyzes structured and unstructured data and natural language sources to identify potential attacks in the IoT environment. The uniqueness of the cognitive platform is resonated by the fact that it can continuously learn from data and derive automated insights to thwart any emerging issue.

SparkCognition took home two awards, one for their security platform, SparkSecure, and another alongside Circadence for Project Ares.

Based on its work at the nexus of IoT, cyber security and AI, Frost and Sullivan recently recognized SparkCognition with its highly selective Excellence Through Technology Convergence Award. To achieve customer value excellence through technology convergence is never an easy task, but it is one made even more difficult due to today's converging markets, competitive intensity, customer volatility, technology collaboration and economic uncertainty—not to mention the difficulty of innovating in an environment of escalating challenges to intellectual property.

"SparkCognition's cognitive solutions and actionable insights into threat dynamics help companies act on warnings of impending failures, preventing unwarranted downtime," said Mohena Srivastava, a leading analyst at Frost & Sullivan. "Bridging the gap between industry need and certified human capability, path breaking cognitive analytics by SparkCognition is poised to become the industry standard."

About SparkCognition

SparkCognition, Inc. is the world's first Cognitive Security Analytics company based in Austin, Texas. The company is successfully building and deploying a Cognitive, data-driven Analytics platform for Clouds, Devices and the Internet of Things industrial and security markets by applying patent-pending algorithms that deliver out-of-band, symptom-sensitive analytics, insights, and security. SparkCognition was named the 2015 Hottest Start Up in Austin by SXSW and the Greater Austin Chamber of Commerce, was the only US-based company to win Nokia's 2015 Open Innovation Challenge, was a 2015 Gartner Cool Vendor, and is a 2016 Edison Award Winner. SparkCognition's Founder and CEO, Amir Husain, is a highly awarded serial entrepreneur and prolific inventor with nearly 50 patents and applications to his name. Amir has been named the top technology entrepreneur by the Austin Business Journal, is the 2016 Austin Under 40 Award Winner for Technology and Science, and serves as an advisor to the IBM Watson Group and the University of Texas Computer Science Department. For more information on the company, its technology and team, please visit

http://www.sparkcognition.com.

About The Edison Awards

The Edison Awards is a program conducted by Edison Universe, a non-profit, 501(c)(3) organization dedicated to fostering future innovators. The Awards have been recognizing and honoring the best innovations and innovators since 1987. They honor game-changing innovations that are at the forefront of new product and service development, marketing and human-centered design, and are one of the highest accolades a company can receive in the name of successful innovation. For more information about the Edison Awards complete program and a list of past winners, visit www.edisonawards.com.

About Frost & Sullivan

Frost & Sullivan, the Growth Partnership Company, works in collaboration with clients to leverage visionary innovation that addresses the global challenges and related growth opportunities that will make or break today's market participants. For more than 50 years, we have been developing growth strategies for the global 1000, emerging businesses, the public sector and the investment community.

Phase Transitions – When a model is screaming out that it needs revision

Jerry M. Schirmer, Ph.D.

June 17, 2016

So, I've been thinking a lot lately about one particular subfield of physics and how it might apply to data. In general, the thing that has been on my mind is the area of Statistical Mechanics, which is the study of how a huge number of particles in atomic-level physics can aggregate together into our macroscopic world, but beyond the large area of stat-mech, I've been thinking in particular about the topic of phase transitions – what happens when these large scale models cease to be consistent with the small-scale behaviour of the system.

Why this is interesting to me is that, in a lot of ways, big data involves the same sort of problem that stat mech does – we try to amalgamate the behaviour of millions of website visitors, or IOT devices, or whatever, into a meaningful model that can be described by a few parameters. When we do this, we should be interested in looking at when our model will suddenly need to be revised or adjusted. So, I'm going to take this space here to talk a bit about how these come about in our physical descriptions of nature, and then speculate a bit on how they might be leveraged in discussing data.

So, let's think about a gas... for simplicity, let's say that it's kept in a well-insulated container. How might we describe it? Well, naïvely, we'd probably go and use a few variables that described the observed state of the gas. We'd use stuff like the pressure P of the gas, its volume V, and its temperature T. If we already know about molecules, we might use the number N of molecules in the gas. If the gas is diffuse enough, we get a relationship between these things that is something like our favorite formula from intro chemistry:

$$PV = NkT$$

where k is a constant called Boltzmann's constant[1]. Now, this isn't the end-all of gas laws, however. If we start to factor in the simplest sorts of interactions between particles, we need to figure that the more dense the gas is, the stronger particles attract each other, and the more space is taken up by the particles, so we get something like:

[1] Now, most of you probably learned this formula as $PV = nRT$. Well, remember that the number of moles in a gas is $n = \frac{N}{N_A}$, where N_A is Avagadro's number. It is the case that $k = \frac{R}{N_A}$, and these two formulae are equivalent.

Continued on next page >>

$$\left(P + a\left(\frac{N}{V}\right)^2\right)(V - bN) = NkT$$

where a and b are empirical constants that depend on the gas under consideration. Now, for sufficiently high values of T, this equation is nice and well-behaved. But it should be easy enough to see that if T is low enough, then you can get behavior that is somewhat crazy. In particular, for constant values of N and T, and sufficiently low T, you can find solutions where $\frac{\partial P}{\partial V} > 0$, which is crazy when you think of it – increasing the volume of the gas increases the pressure! No stable gas can satisfy these conditions. You might think this means that the Van der Walls equation is junk (and it's true that this equation, too, is an approximation), but what it really means is something more interesting – the Van der Waals equation of state is telling you that you aren't having a gas at all anymore – the gas is undergoing a phase transition, and is liquefying or solidifying. And, on the other side of that phase transition, we will need a new equation of state to describe a liquid or a solid.

Now, what does this mean for data? In a lot of ways, we are doing the same thing with big data. We are measuring the net effects of millions of individuals doing billions of things, and tracking their aggregate behaviour using a model that has far fewer degrees of freedom than the underlying data. And it's not the model being wrong – it's the model screaming out that it no longer applies, and needs to be replaced with a model that applies more directly to the underlying situation.

For instance, imagine that we're running a regression on a series of sensors for a predictive analytics platform, such as SparkCognition's SparkPredict, and we are attempting to predict future sensor output on a wind turbine from previous sensor output. Generically, we're going to be measuring a bunch of things like airflow velocity, temperature, pressure, etc. We build a model, train it, deploy it, and watch it evolve, and at first, it works beautifully. But then, winter comes, the behaviour of the turbine changes, and we're predicting negative pressure. We know that's impossible, but that's just the model telling us that we need to come up with a new model, applicable to winter. We've undergone a phase transition, and we've learned about it from our model, itself. There are obviously much deeper dives to take here, but one of the first lessons is always that fundamental question that all mathematicians and scientists should ask themselves – is my model making sense?

WHICH CAME FIRST: THE DATA SCIENTIST OR THE MILLENNIAL?

It is perhaps no coincidence that a math-heavy technological discipline requiring complex statistical analysis *and* communication and design skills has reached its peak at a time when the millennial workforce is now the majority in businesses around the world. Statisticians, Programmers, Computer Scientists, and Designers have been around as long as many of us can remember, but it is only within the last 10 years that "data scientists" have come to merge all of these disciplines into one job title. At the most basic level, a Data Scientist takes massive amounts of data, interprets and analyzes it, then makes it usable and easily consumable.

It was around 30 years ago that computers became household items and about 20 years ago that the internet transformed the way we use those machines. Since that time, technology has become pervasive in our culture. Most of us understand "intrusive" technology (Social Networks, smart phones, online shopping sites predicting our needs, etc.), but it's the "background" of today's technology that dictates the needs for people with the unique qualities described above. For example: a pipeline company has thousands of miles of underground infrastructure, making visible inspections impossible. With today's technology, sensors can be attached to these pipelines to take readings on everything from flow to maintenance issues.

There could be thousands of data points generated per second! A Data Scientist will then take that data, visualize and plot the data to gain intuition of what is happening, generate new variables when applicable, apply Machine Learning, then interpret and disseminate the data in an easily discernible output model.

THE TRUTH IS, THESE YOUNG MEN AND WOMEN ARE THE MOST EDUCATED GENERATION IN AMERICA'S HISTORY AND ARE THE FIRST GENERATION TO BE COMPLETELY "WIRED".

Countless articles have been written, seminars given, and speculations made about the generation born circa 1983-2000. If you were to ask the person next to you their opinion on this generation, chances are they would have plenty of opinions to render, whether good or bad. The truth is, these young men and women are the most educated generation in America's history and are the first generation to be completely "wired". In general, they are multitaskers, prefer to work in collaboration, have a need for instant gratification, and do not settle for status quo. These are the perfect qualities for someone who needs to make sense of the nonsensical: They are skilled enough technically to wrangle massive amounts of information; learned enough to interpret and rewrite large amounts of data logically; and creative enough to make it all easily understood.

These advances in technology happened at a time when Baby Boomers were raising their children in the manner that produced particular and unique characteristics; characteristics that make it possible to marry multiple disciplines into one, seemingly disparate job description (mathematical ability and creativity). So, perhaps it's not a matter of solving the conundrum "which came first", but rather, being grateful for the "perfect storm" of circumstance that brought it to fruition.

LEADING THE AI REVOLUTION

The cognitive movement has a new super weapon

BY KIMBERLY ERLER

In a 2015 speech delivered at the Willard Hotel, Deputy Secretary of Defense,

Bob Work, explained how the US military was embarking on a major program focused on driving innovation,

cutting down development cycles, and maintaining the country's edge over current and future adversaries. The strategy, dubbed "The Third Offset", relies on fast prototyping cycles and an embrace of bleeding edge technology. A pillar in this strategy is an increased reliance on autonomous systems powered by smart, cutting edge sensors and Artificial Intelligence algorithms.

From Battlefield Intelligence to Artificial Intelligence

"Today, our country faces a great many challenges, but perhaps none as significant as the rapidly evolving cyber threats that compromise our nation's critical infrastructure."

--Gen. John Allen (Retd.)

More than ever, the Department of Defense understands that military superiority is a function of technological capacity. With this as the strategic backdrop, it is perhaps no surprise that one of the United States' most respected and accomplished war-time military leaders, US Marine Corps General John R. Allen (USMC Retd.), recently announced that he was joining the Board of Directors of leading Artificial Intelligence firm, SparkCognition.

General Allen's list of credentials is impressive. He was Commander of the International Security Assistance Force (ISAF) and U.S. Forces Afghanistan (USFOR-A), deputy commander of US CENTCOM, and most recently Special Envoy for the President of the United States. His deep experience spans decades and features operations in the Americas, the Middle East and Europe, including Operation Sea Signal in the Caribbean in 1994, Operation Joint Endeavor in the Balkans from 1995 to 1996, Operation Iraqi Freedom in Iraq from 2007 to 2008, and Operation Enduring Freedom in Afghanistan from 2011 to 2013.

Once he returned from his Afghanistan assignment, President Barack Obama appointed General Allen as Special Presidential Envoy for the Global Coalition to Counter ISIL (or "Daesh"), where he led the complex assignment of building, from conception, a robust international coalition that would undertake a wide range of political, diplomatic, military, economic, and other efforts to thwart Daesh. In no small part due to General Allen's stewardship, today the United States is leading a 65-member global coalition that is rolling back Daesh's territorial gains in Iraq and Syria, advising and assisting Iraqi Security Forces, and constricting Daesh's financing and operational capabilities.

So what drew Allen to SparkCognition? Since its founding, the Austin based AI company has racked up a long list of accomplishments. It's offering was named the most innovative application in the IBM ecosystem in 2014, it became the only US company to win the Global Nokia Innovation Challenge in November, 2015, and was named by industry-leading analyst firm, Gartner, as a "Cool Vendor" for Smart Machines in the same year. But most importantly, the company has acquired an impressive list of clients. For its customers, some of the largest global corporations, SparkCognition has built, delivered and deployed systems that act like human experts; they can detect problems with cyber physical assets, notify staff in advance and assist with remediation. These seemingly magical capabilities are made possible by the company's specialized Artificial Intelligence algorithms that can predict failure, converse with users in natural language to prescribe solutions, and present not just insights, but the evidence to back them up. Precisely the type of AI platform that could be a game-changer in context of the Third Offset strategy.

While the third wave of Artificial Intelligence is a new phenomenon, Allen's exposure to high-tech programs and the importance of incorporating bleeding edge tech into the Services is not. In fact, he has had a long history of involvement with complex programs that provide the Armed Services with a quantum leap in capability. In the mid-1980s, then-Captain Allen, as the Marine Corps Fellow to the Center for Strategic and International Studies (CSIS), participated in the Center's landmark study on strategic mobility, a critical area of American readiness and responsiveness to the Soviet threat and to global instability. In this study, Captain Allen was the lead researcher and writer on the next strategic airlifter, which at the time revolved around a

variant of the C-5, or an as-yet-to-be-built aircraft, the C-17. His research and presentations on the comparative usefulness of these aircraft across the conflict spectrum, within the context of the CSIS study, contributed to final decisions being made on the next generation airlift platform. He has also been a keen observer of global strategic trends. As a general officer, he served as the principal director of Asia-Pacific policy in the Office of the Secretary of Defense.

If being a military leader who fought major wars and spearheaded numerous military actions wasn't enough, Allen has also demonstrated his poise and ability as a statesman who has excelled in building alliances.

Amir Husain, SparkCognition's Founder and CEO, cites Allen's distinguished accomplishments as a "soldier and a statesman" to explain the company's deep interest in working with him. "General Allen has served our country with distinction for almost forty years and understands how critical AI and related advanced technologies are for securing our nation's cyber and physical assets." Husain continued, "General Allen is not only one of our most brilliant wartime military commanders, he is also a statesman and scholar with immense policy experience. This makes him one of a handful of global leaders with a profound understanding of the growing cyber-physical challenges the world faces."

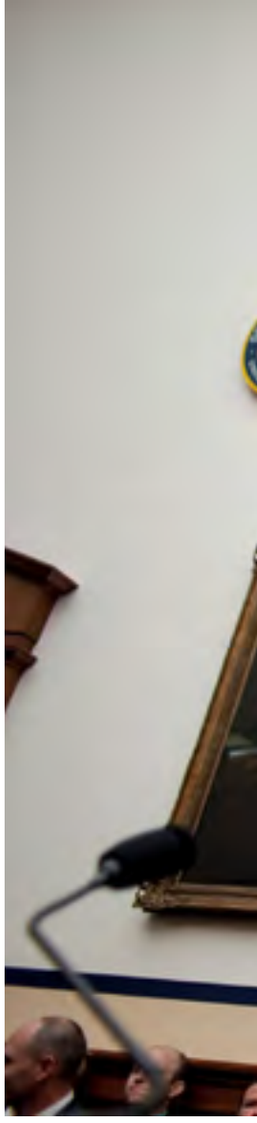
These cyber-physical challenges Husain speaks of are growing at break-neck pace. With episodes like the cyber attack on the Ukrainian and Turkish power grids, the ability to employ cyber capabilities to affect physical infrastructure has become a front and center concern for military planners, homeland security strategists and governments the world over.

SparkCognition was founded to address these very challenges. The company's machine learning models have been deployed at some of the leading commercial organizations in the United States, including multi-billion-dollar pump company, FlowServe Corporation, leading utility NextEra Energy corporation, and one of the largest wind operators in the US, Invenergy Corp. Through the use of Artificial Intelligence and Machine Learning techniques, SparkCognition's software monitors sensors on physical and virtual assets, continuously learns from data, and derives intelligent insights to secure and protect infrastructure round the clock. The company's technology is capable of harnessing real time sensor data and learning from it continuously, allowing for more accurate risk mitigation and prevention policies to intervene and avert disasters. This cybersecurity centered solution analyzes structured and unstructured data (including natural language sources) to identify potential attacks in the IT and Internet

Since its founding, the Austin based AI company has racked up a long list of accomplishments. In 2015, it became the only US company to win the Global Nokia Innovation Challenge

SparkCognition [is] driving innovation in a field that is vital to our national security. I consider this work to be a national asset.

Allen led US and Allied armies in Afghanistan as Commander ISAF.

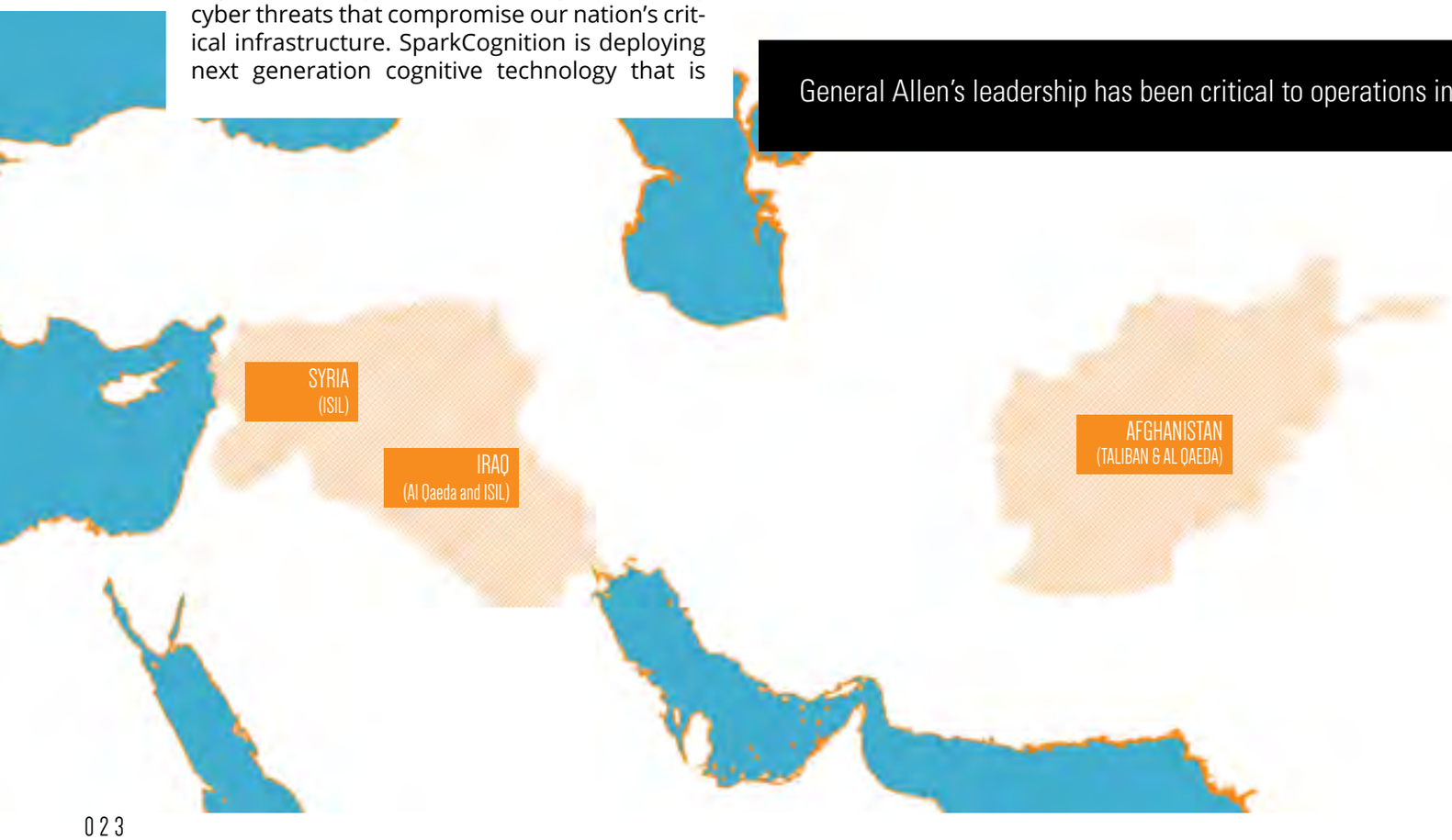


of Things (IoT) environments. The uniqueness of the cognitive platform is underscored by the fact that it can continuously learn from data and derive automated insights to thwart emerging issues, without the need to build manual models.

For his part, Allen is simply doing what he has done his entire adult life. He may be on a new stage, but he is working hard as ever to secure the United States and deliver every possible advantage to its defense services. When asked about his move from warfighter to a strategist for AI applications in National Security, the General pointed to innovations and advances in AI technology that are impossible to ignore; "SparkCognition [is] driving innovation in a field that is vital to our national security. Today, our country faces a great many challenges, but perhaps none as significant as the rapidly evolving cyber threats that compromise our nation's critical infrastructure. SparkCognition is deploying next generation cognitive technology that is necessary to address these realities, and I consider this work to be a national asset."

The significance of this partnership will become clearer over time. But considering General Allen's incredible accomplishments on and off the battlefield, coupled with SparkCognition's innovative AI technology, the potential upside for America's burgeoning foray into AI-powered security is immense. Leaders like Gen. Allen, and companies like SparkCognition, are determined to ensure that the United States remains at the forefront of innovation.

General Allen's leadership has been critical to operations in:



General Allen is not only one of our most brilliant wartime military commanders, he is also a statesman and scholar with immense policy experience.

Gen. Allen served as President Obama's Special Envoy for Middle East peace.

ML/AI & CYBER-WARFARE

2002-(ISC)²//
International Information Systems Security Certification Consortium confers its 10,000th CISSP certification.

2007- UNITED NATIONS//
Hacked by Turkish Hacker Kerem125

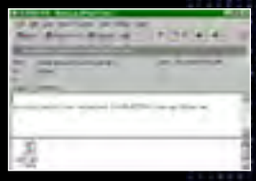
2012 - THE YEAR OF THE HACKER//

Partial Active Hacker Groups: 0xOmar, The Hacker Encrypters, Team Appunity, Attila Nemeth, Swagg Security, FORTYS3V3N, UGNazi, Elite hacker sl1nk

HACKED: Israel, France (SCADA), Norway (SCADA), Russia (SCADA), Spain (SCADA), Sweden (SCADA), & US (SCADA), Facebook, Marriott, Foxconn, Google, Yandex, Microsoft, Gmail, MSN, Hotmail, PayPal, WHMCS, MyBB, Farmers Insurance, MasterCard, & several other high-level Govt. sites, CenturyLink Inc, Multinational Telecommunications and Internet Service Provider Company, Telecom Argentina S.A, British Telecommunications and the Tunisian Internet Agency... and countless others.

2014 THE WHITE HOUSE//
Computer system is hacked

2000-ILOVEYOU WORM//
infected millions of computers worldwide within a few hours of its release

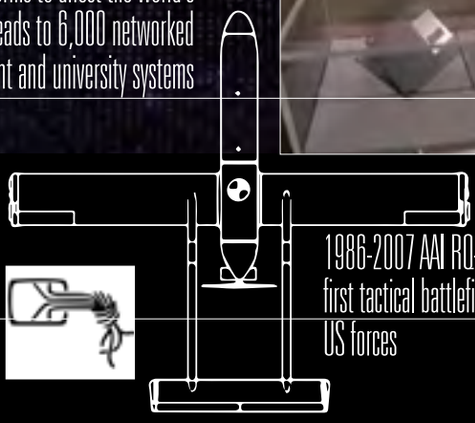


1996-US DOD HACKED//
Hackers alter Web sites of the United States Department of Justice (August), the CIA (October), and the U.S. Air Force

1988- Morris Worm//
one of the first recognized worms to affect the world's nascent cyber infrastructure spreads to 6,000 networked computers, clogging government and university systems

1977- DES IMPLEMENTED//
in a computer chip, made it possible at least in principle to control the spread of encryption technology through export restrictions.

1981- CCC//
Chaos Computer Club forms in Germany.

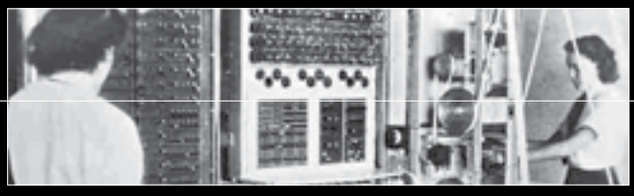


1986-2007 AAI RQ-2 PIONEER//
first tactical battlefield drone used by US forces

1968-73-OPERATION IGLOO WHITE - VIETNAM WAR//
A covert US joint military electronic warfare operation with state-of-the-art operation utilized electronic sensors, computers, and communications relay aircraft in an attempt to automate intelligence collection.

1958-DARPA//
the Advanced Research Projects Agency (ARPA) by President Dwight D. Eisenhower

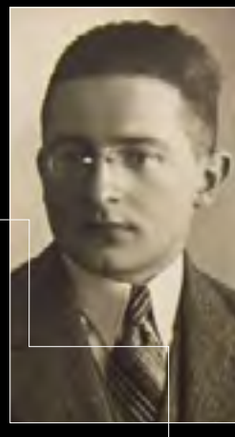
1943- René Carmille//
French computer expert hacked the punched card used by the Nazis to locate Jews.



1943-45-COLOSSUS MK I COMPUTER//
British codebreakers designed to encrypt radiotelegraphy messages from the German army commands

1940-ULTRA//
Bletchley first succeeded in reading German code - Information Obtained named ULTRA

1930-40-SOVIET UNION//
Soviet Teletanks: One of the first forms of remote controlled unmanned military robot tanks



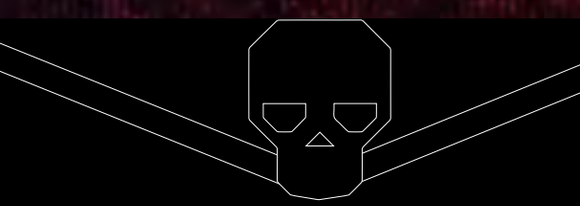
1932-POLAND//
Rejewski/Zygalski/Róyzcki broke the Enigma Machine Code

Cybercrime in 2015 cost businesses globally between $400 ~ $500 billion annually. For 2016 the cybercrime costs estimate is $2-$3 trillion globally.

CYBER-ATTACKS ON THE RISE

$90 Trillion

$90 TRILLION COULD BE LOST BY 2030 DUE TO CYBERATTACKS IF CYBERSECURITY FAILS TO ACCELERATE



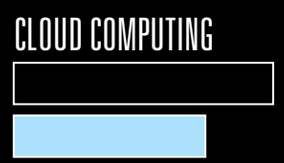
Demand for information security products and services by the U.S. federal government will increase from $8.6 billion in FY 2015 to $11 billion in 2020, according to :

"Deltek's Federal Information Security Market Report"

TOO FEW CYBERSECURITY PROFESSIONALS

62% OF FIRMS FEEL THEY HAVE TOO FEW SECURITY PROFESSIONALS

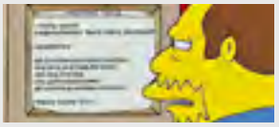
ARTIFICIAL INTELLIGENCE IS THE FUTURE



CYBER SECURITY IS THE NUMBER ONE PRIORITY FOR BOTH INDUSTRY & GOVERNMENT SECTORS

AI SOLUTION

EVENTS YOU SHOULD KNOW ABOUT. FROM THEN AND NOW.



JULY 2
IBM ANNOUNCES THE MODEL 650 COMPUTER

The world's first mass-produced computer

JULY 10-14 CISCO LIVE
Cisco Live is the destination for the education and inspiration to thrive in the world of digital business. Join thousands of technology innovators for a transformational experience that includes today's IT visionary thought leaders, more than 1,000 education sessions, Cisco's top partners, and numerous opportunities to build the connections.

JULY 13
EMBRACE YOUR GEEKINESS DAY

JULY 14
PI APPROXIMATION DAY

JULY 25-28 ICALT2016
An annual international conference on Advanced Learning Technologies and Technology-enhanced Learning organized by IEEE Computer Society and IEEE Technical Committee on Learning Technology. It will be held at The University of Texas at Austin.

JULY 28
SYSTEM ADMINISTRATOR APPRECIATION DAY

JULY 30-AUG 04 BLACKHAT 2016
Black Hat is the most technical and relevant global information security event series in the world. For more than 18 years, Black Hat has provided attendees with the very latest in information security research, development, and trends in a strictly vendor-neutral environment.

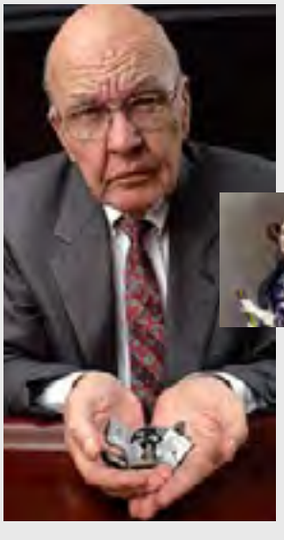
AUG 1-4
NI WEEK 2016

NI Week brings together the brightest minds in science and engineering, with more than 3,200 leading innovators representing a wide variety of industries.

AUG 21
THE IBM PERSONAL COMPUTER, COMMONLY KNOWN AS THE IBM PC, WAS INTRODUCED ON AUGUST 12, 1981

SEP 9
GOOGLE WAS FOUNDED

SEP 12
JACK KILBY SUCCESSFULLY TESTS THE FIRST INTEGRATED CIRCUIT AT TEXAS INSTRUMENTS.



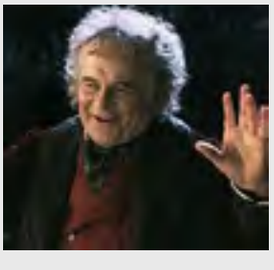
SEP 12
INTERNATIONAL PROGRAMMER'S DAY

SEP 20
SOFTWARE FREEDOM DAY

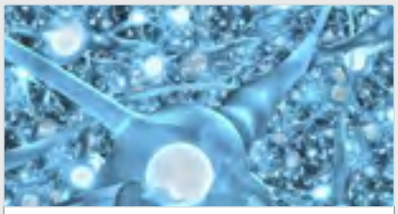
An annual worldwide celebration of our favorite thing: Free Software!

SEP 22
HOBBIT DAY

Birthday of Bilbo and Frodo Baggins in The Hobbit and The Lord of the Rings



SEP 28
SUPERCOMPUTER PIONEER SEYMOUR CRAY WAS BORN



the home of AI info
@homeAIinfo 12:11 PM - 9 Jun 2016

Research showing why hierarchy exists will aid the development of artificial intelligence http://homeai.info/blog/news-stories/research-showing-why-hierarchy-exists-will-aid-the-development-of-artificial-intelligence/ ...

CognitiveScale
@CognitiveScale 10:38 AM - 12 Mar 2016

The fab four getting ready to talk about #AI. Come over for the 5 pm panel. #sxsw2016 http://schedule.sxsw.com/2016/events/event_PP92937 ...

Open Box Software
@openboxsoftware 02:08 PM - 21 May 2016

Building artificial intelligence models with Internet-of-Things data http://bit.ly/1VdZ7BE

Verizon Ventures
@VerizonVentures 09:11 AM - 31 May 2016

.@Sparkcognition dives into the data and #analytics behind oil & gas on their blog: http://vz.to/1U10hvs

Rita Patel Jackson
@ripjay 03:16 PM - 15 May 2016

Congrats to @SparkCognition chosen as a 2015 Austin A-List Startup! https://youtu.be/avy1m7NBM_M via @YouTube #IBMWatson @amirhusain_tx

AtosDigital Industry
@Atos_IDA 11:58 AM - 9 Jun 2016

Tech moguls declare era of artificial intelligence | @Reuters RT @tdav http://buff.ly/1P9aAMn #Tesla #AI

A.I. SOCIAL

AP Guha
@APGuha May 20

Cool> @SparkCognition combining #AI #iot #AR http://buff.ly/1NBWUP4 #machinelearning #internetofthings #AugmentedReality #oilandgas

Building artificial intelligence models with Internet-of-things

SparkCognition, a company with automatic model-building technology that sifts sensor and other instructed data to predictfailures and breaches has...

cio.com

USA TODAY Tech
@usatodaytech 04:30 PM - 1 Jun 2016

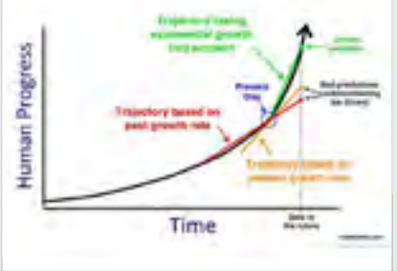
Jeff Bezos: Artificial intelligence's impact is 'gigantic'

Recode
@Recode 7:30 AM - 14 Jun 2016

Can artificial intelligence wipe out cyber terror?

Stephen Law
@EPTmagazine 06:48 PM - 14 May 2016

US military turns to Silicon Valley for an edge in #artificial_intelligence.



Accenture Technology
@AccentureTech 2:15 AM - 9 Jun 2016

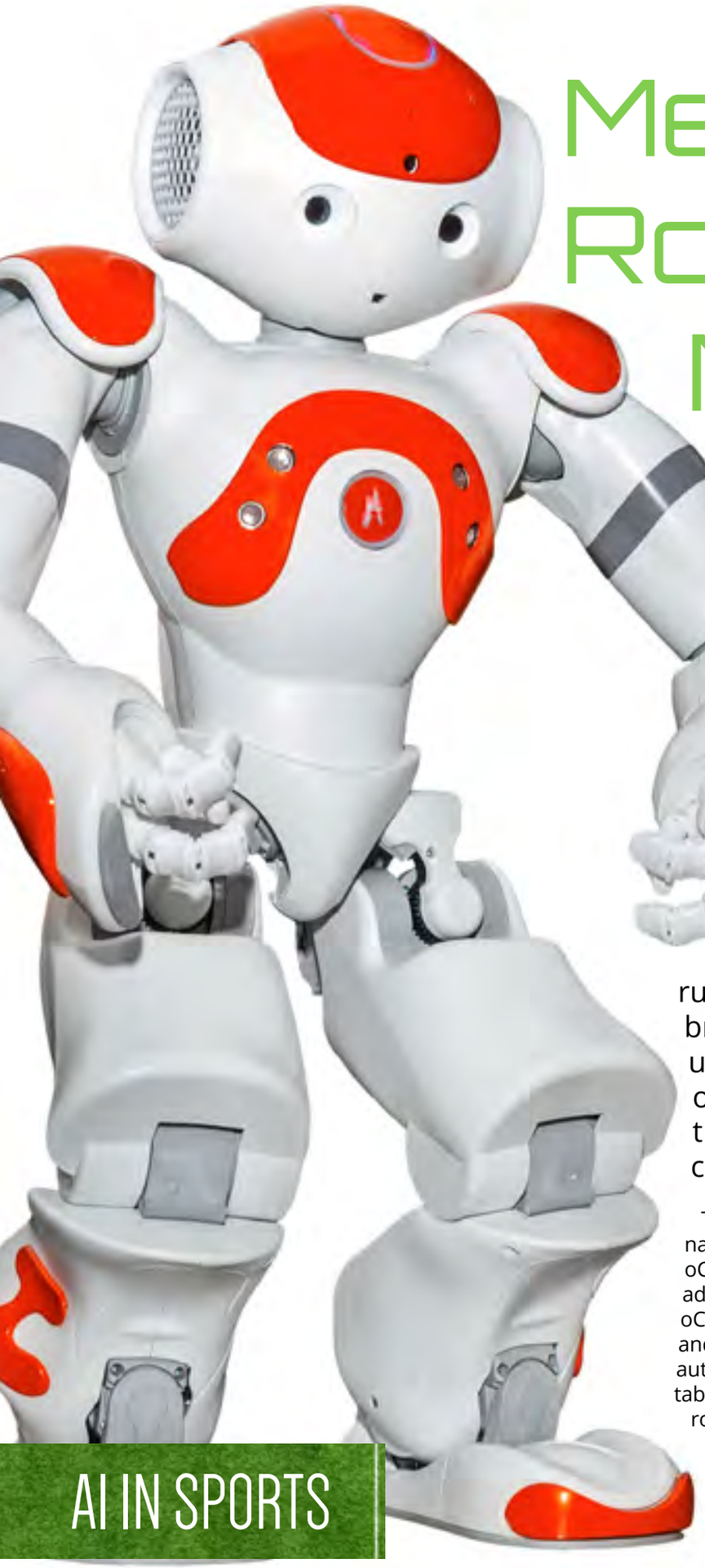
The #AI Revolution: Why the road to superintelligence is so hard to predict: http://bddy.me/1tezgyg @waitbutwhy

Mike Quindazzi
@MikeQuindazzi 11:20 AM - 12 Mar 2016

#USAirForce deploys #AI Cyberspace Hunter Weapon System to scour military networks for #cybersecurity holes.

Deep Grammar
@DeepGrammar 04:30 PM - 7 Feb 2016

My guess is that, in 30 years, military superiority will come down to which nation has the most powerful artificial intelligence.



Messi, Ronaldo... Mr. Roboto?

BY JOHN KING

On a hot Central Texas afternoon in the middle of June, members of SparkCognition's marketing and communications team were attending soccer practice at the University of Texas at Austin (UT). They weren't running up and down the field, they hadn't broken a sweat, they weren't even suited up. They were there as spectators to watch one of UT's best soccer teams prepare for the year's most prestigious international competition, the RoboCup.

That's right, the RoboCup. It's not your typical soccer tournament. Hosted in Leipzig, Germany this summer, the RoboCup is an "international scientific initiative with the goal to advance the state of the art of intelligent robots." The RoboCup competitions provide a channel for the dissemination and validation of innovative concepts and approaches for autonomous robots under challenging conditions. When established in 1997, the original mission was to field a team of robots capable of winning against the human soccer World Cup champions by 2050. And while we may be a ways off from that reality, the University of Texas at Austin RoboCup team is competitively advancing this mission, led by one of the top coaches in the league.

Peter Stone's office, and the Robotic Soccer Lab, is housed in the UT Computer Science Department's Gates Dell Complex, where on any given day one will see autonomous robots roaming the hallways. Dr. Stone, or on this particular afternoon, Coach Stone, is the David Bruton, Jr. Centennial Professor of Computer Science at UT. Having received his Ph.D. in 1998 and his M.S. in 1995 from Carnegie Mellon University, both in Computer Science, Dr. Stone is a leading researcher and professor in the field of Artificial Intelligence. His focus areas include planning, machine learning, multiagent systems, robotics, and e-commerce. His long-term research goal is to create complete, robust, autonomous agents that can learn to interact with other intelligent agents in a wide range of complex and dynamic environments. As a lifelong soccer player with a passion for the sport – at one point in his career Stone almost made it to the major league - Coach Stone is pursuing his research goals by scoring goals on the soccer field, and he is making major progress.

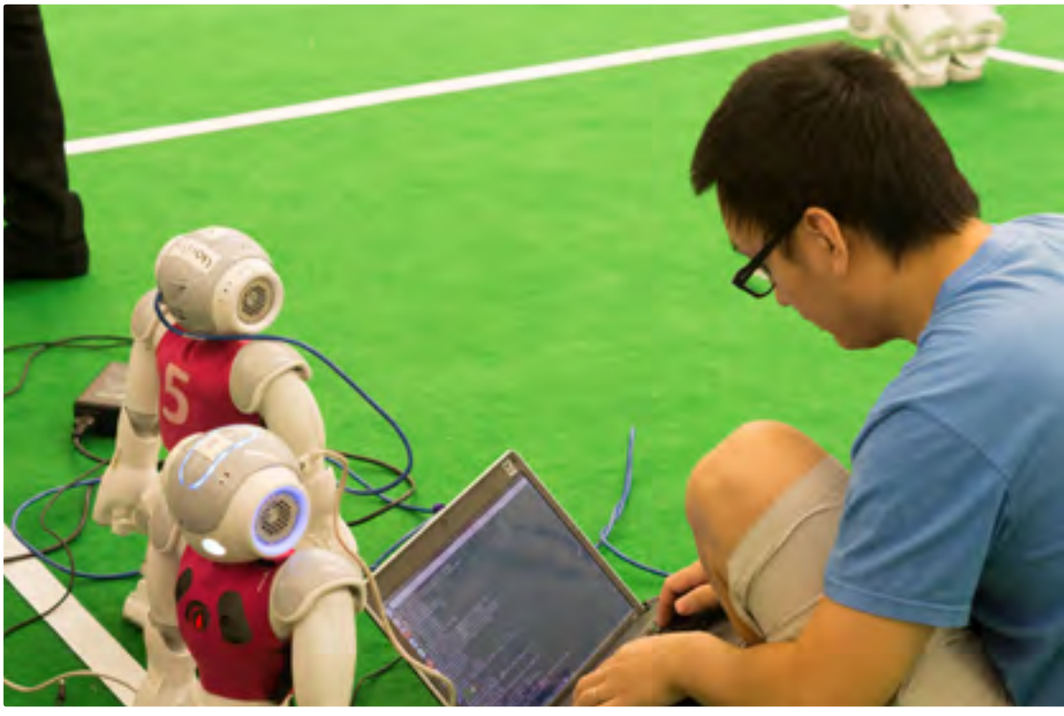
WE MAY SEE A ROBOT BEAT A HUMAN AT A MECHANICAL SPORT SOONER THAN ANTICIPATED

Since 2002, Coach Stone has led the UT Robotics Team to six RoboCup championships in the simulation challenge (computer software), and one in the standard platform challenge (robots). As a researcher, Dr. Stone works with his students year-round to advance his and their knowledge of the field, keeping abreast of the leading research, and publishing some of their own. As a champion competitor, Coach Stone leads a team of student researchers who share his interest, or more typically his passion, for the sport of soccer and the advancement of robotics.

When we caught up with Dr. Stone, he was leading a meeting of his RoboCup team, checking in on the state of their robots and the code which directs their play. This meeting was akin to a practice. Coach Stone began with a status check of where his team members were with their code, and then had them 'drill' their software. The practice resembled that of young children first learning to play soccer. Some robots made their way to the ball while others wandered the field. Some fell down and others stood with their 'heads' on a swivel, gauging where on the field they were in relation to the ball. Like parents of young children, the human team members followed the robots around the field, ensuring that they were on track and safeguarding them from hard falls. All the while, Coach Stone questioned his team (the humans) on approach and reasoning. He guided them with solutions to improve their programs and encouraged them to press forward with urgency – the competition is only a few weeks away.

In retrospect, the practice was quite fascinating. The fact that these robots were behaving in a similar fashion as young children on a soccer field leaves one surmising that the next step is adolescence. The improvement over the last decade has been phenomenal, and if Moore's Law holds water, we may see a robot beat a human at a mechanical sport sooner than anticipated.

As an athlete, I was surprised by how similar the RoboCup practice resembled a walk-through or film session. Perhaps this was the most interesting aspect of the practice - the human dimension. Dr. Peter Stone was, for the hour, Coach Stone. And as a coach on the field, he guided his team with stern direction, vision, and encouragement. He has led teams to championships before, and he will likely do so again.



After Coach Stone ended practice, we caught up with Doctor Stone for an interview. What follows is a conversation with one of the country's leading artificial intelligence and robotics researchers, and a top RoboCup coach.

Cognitive Times: Dr. Stone, what are your specific research areas and what are the goals of the lab that you run?

Peter Stone: Our lab is called the Learning Agents Research Group. The unifying long term goal is trying to create fully autonomous agents. It could be robots, it could be software agents that can exist autonomously in the real world for extended periods of time. That means dealing with lots of uncertainty with perception and with action. That's the unifying theme. The sub areas of artificial intelligence that I work on are known as machine learning. In particular reinforcement learning which is learning about the effects of actions. Also multi agent systems - how do you get multiple autonomous entities, individuals, and programs to either cooperate or work against each other, or to just coexist such that they are all achieving their own goals and reasoning about each other's goals. That's what's known as multi agent systems.

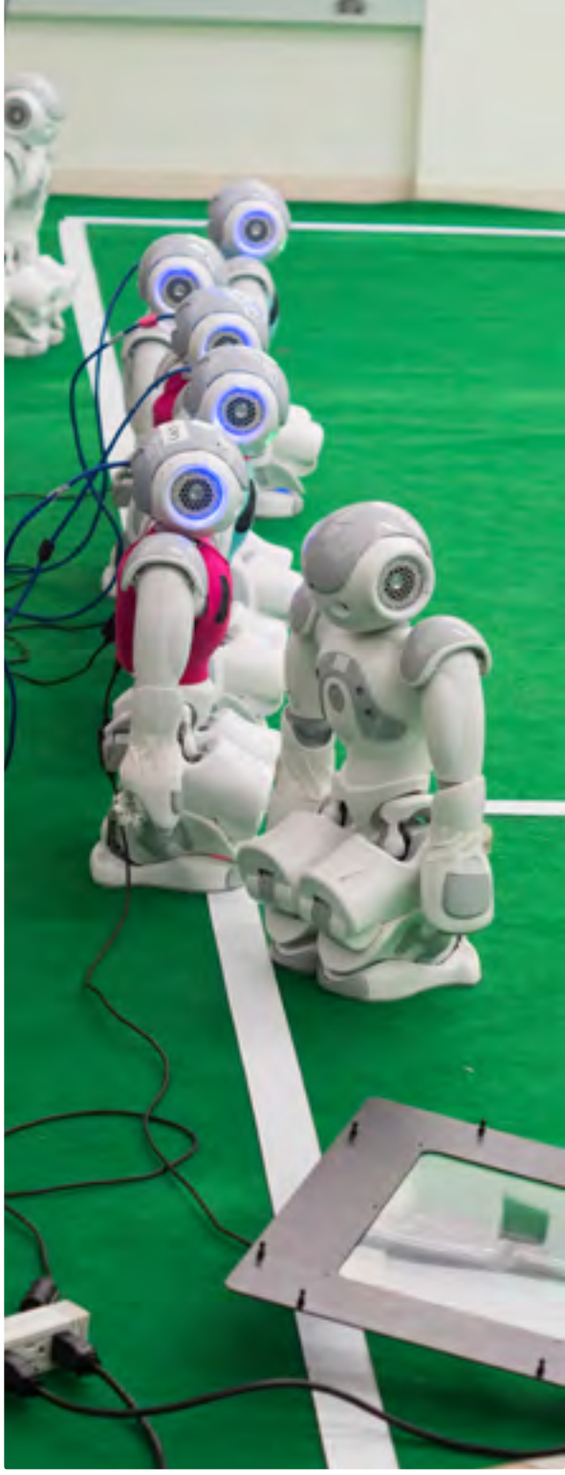
So reinforcement learning, multi agent systems, and then I use several test bed domains that involves robotics. We have the robot soccer team which involves learning, it involves multi agent systems, it involves robotics. We also have robots you may have seen wandering about the hallways; that's our building wide intelligent projects. We have robots that can figure out where they are in the building and can interact with people. The long term goal of that project is to get to the point where people walk into the building and expect to see robots and interact with them to either do things that are entertaining or useful in some way. The robots should exhibit a clear intelligence or knowledge of everything that's going on in the building. The long term goal of the robot soccer project, it's a worldwide initiative called RoboCup, is by the year 2050 to have a team of human robots that can beat the best soccer team on a real soccer field.

Cognitive Times: And how far away are we from creating that goal, from creating the next Ronaldo?

Peter Stone: It turns out to that there is a lot of dimensions to that question. There is the physical hardware aspect of it. A robot that is as physically agile as an athletic person is a long ways off. There have been some examples of robots that show impressive degrees of agility, but then to combine that with sort of long running autonomy and the ability to make decisions, that is the software aspect of it, we are still a long ways off.

You sort of saw what is known as the standard platform league in RoboCup, where we all have the same hardware, that's not by any stretch the state of the art of robots in the sense of agility. There are robots that can move faster, with more agility. Those are chosen with a particular price point in mind. It's a nice, stable platform that allows us to push the limit of how fast they can move and also think about the strategic levels. There are enough teams from around the world who can have multiple of these robots so that we can have five versus five competitions.

We also participate in the 3D simulation league which is where there are eleven robots on each team, but it's all in software simulation. There we can even lift the next level up and think at more of the strategic multi agent level. There are different leagues in RoboCup as well, there are some with wheeled robots that moves much more quickly than these. We have had people versus robot games against those robots every year since 2007 and it's getting harder- but people are still much better than the robots.



IN TERMS OF ROBOTS, WE ARE TRYING TO CREATE THE NEXT GENERATION OF ROBOTS THAT PEOPLE CAN INTERACT WITH.

Cognitive Times: Dr. Stone, you have a great record at the RoboCup, you seem to be very prevalent in the robotics league, you have a bookcase full of trophies, a lot of accolades - you are winning a lot. What is the secret sauce, what's the magic here?

Peter Stone: I think the key is that over the years I have really deeply integrated my RoboCup team into PhD level research. There are some people who do RoboCup on the side, there are some of my students who you saw in the group meeting there who are doing RoboCup on the side, it's not their main research project topic. But for many of my students there is actually something related to RoboCup that ends up playing a big role in their PhD thesis. It's time when they are very motivated to come up with a new algorithm because not only is it going to help our team, but it is also pushing the frontier of research. We have had a lot of research papers that have resulted from our contributions in RoboCup. I think that's what makes it so that I can be doing this at a level of very deep involvement by top level graduate students - because it's very closely tied to their research.

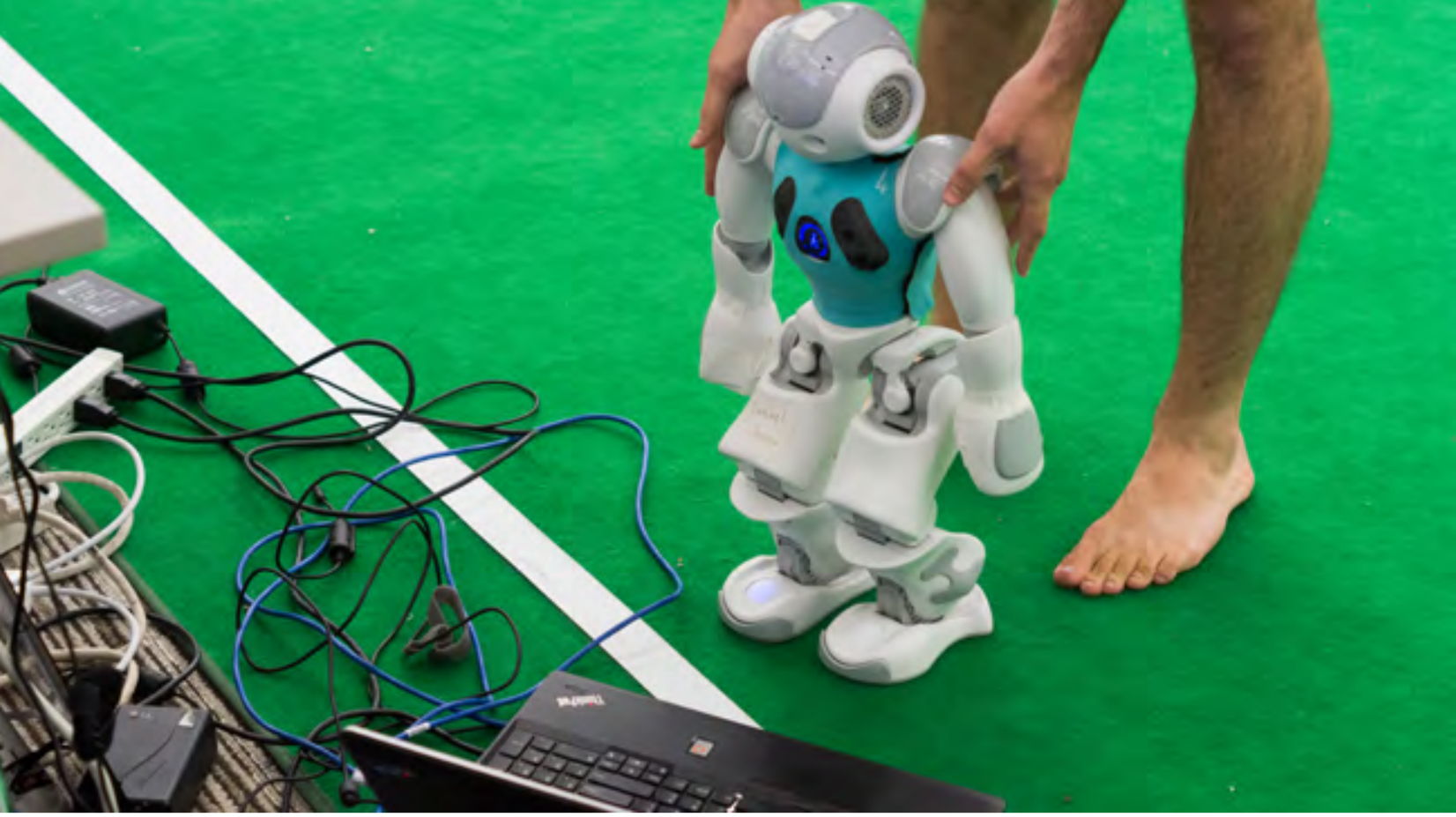
Cognitive Times: So, integration with the highest level of academy. I have read that your goal is to have complete robust autonomous agent that can learn and interact with other intelligent agents on a wide range of complex and dynamic tasks. We saw some of that in the soccer lab and we have seen robots roaming the halls here. You mentioned having guests eventually able to walk into the UT Computer Science building expecting to see a robot. I know that you also do some work with autonomous vehicles. What can we expect to see, or what is your hope, for the future of robotics?

Peter Stone: In terms of robots, we are trying to create the next generation of robots that people can interact with. This building is full of students who are trying to get the robots to be out and about among the students and doing things that students want to do. That is the project we are really focusing on, next generation robots and robotics.

There are other domains, I have a student who just finished work on autonomous bidding agents. These are agents that bid in market based systems where there are multiple other agents they need to cooperate or compete with in an economy. I have one student who is working at the intersection between machine learning and music. That's another form of interaction with the machines. We're asking if we can learn people's preferences for sequences of songs, can we learn the impact that music has on people's decision making? There are a wide variety of domains that can serve as test beds for the study of robust autonomous agents. I basically try to give my students a lot of freedom in terms of their applications as long as there's some tie to the main themes of the lab - reinforcement learning, multi agent systems, and robotics.

Cognitive Times: You have talked about reinforcement learning. What about reasoning? Do you think that reasoning plays a role here? Is that an approach that your students are employing?

Peter Stone: Yeah, we have a collaboration with Vladimir Lifschitz, who works in logic based reasoning, formulation of action languages. We had a paper last year at the main AI conference on integrating common sense reasoning with dialogue systems on a mobile robot. For example, if a robot heard a person at 9:00 am speaking to the robot and saying "please bring me toffee", with common sense reasoning and the right knowledge representation on the line, the robot can reason that at 9:00 am it's more likely that the person is asking for coffee rather than toffee. Just by setting the priors that at that time of day it is more likely for a person to ask for coffee than toffee, this sort of integration of reasoning and knowledge into the whole perception system can make a big difference.



Cognitive Times: It's clear that over the span of the RoboCup there have been tremendous improvements in robotics and machine learning. What do you see as the key challenges today that you face, that your students face? Are the challenges more algorithmic or mechanic?

Peter Stone: They both go hand in hand. As the mechanical engineering improves, as the computational power improves, it gives us more capabilities and more software challenges to try to rise up and make better use of the hardware and technology. I focus more on the software side. So we are not making the mechanical engineering improvements in my lab but we are certainly trying to keep abreast of them and always using the best new hardware, because yeah, it provides different capabilities and different software challenges.

Cognitive Times: We talked about reinforcement learning and reasoning. In the practice arena, when the robot is active in the lab, one can see them thinking. They are turning their heads trying to find the ball, they are getting a sense of where they are on the field. Could you explain in high level terms how the robots' decision-making process works when they are out there playing soccer?

Peter Stone: Yeah, I mean what you see is not them thinking; you are seeing them acting. You are seeing them behave. Really, you are projecting onto them the concept of thinking and what you would do if you were in their position. People are very quick to anthropomorphise robots or any kind of object.

Really what's going on is that there are several different processes. There is a vision process at first, which is just sensing the world, seeing where is the ball, where is the line, where is the goal, where are the different sorts of recognizable objects - that's the vision process. Then on top of that, consuming the output of vision is what we call localization – knowing where the robot is and where the other object, the ball, is on the field. The robot is keeping a probabilistic representation of where it is at any given time, where it thinks it is most likely to be, but then there are a lot of other places that it might be. And then on top of that, there is more of a behaviour-based system. You can think of it as sort of a finite state machine. If I am at the ball, then I should kick, if I am not at the ball I should walk towards the ball. If I don't know where the ball is I should be looking for the ball. There is communication involved, the robots are sharing knowledge of where the ball is and what they are doing so that they are all not going to be doing the same thing at the same time. Underneath that are the action modules, the actual low levels of where the robot sets its joints after it has decided to kick- how do you actually execute that kick, how do walk without falling, how do you get up after you have fallen over. So there is this pipeline of vision, localization, behaviour, and action.

Cognitive Times: How far along do you think we are from machines that actually do think? You are right, I mean I stand there and I look at those robots and say, "oh they are thinking. That robot is thinking about where it is on the field and were the ball is", but I guess what you are saying is that it's going through an action sequence?

Peter Stone: Well in some sense that's what thinking it is. That's what you are doing as well. There is a sequence of information processing that's happening in your brain. So, it is fair to say that the

robot is thinking. Just be careful to say it's not doing it the way a person would do it, or the way an animal would do it. But, in the sense the thinking means taking in information through your sensors and deciding what actions to execute- then the robot is thinking.

Cognitive Times: How do you and your team and your colleagues evaluate the progress of AI development, specifically to robotics lab? What are the benchmarks, the goals that you all are setting, and how are you all looking at the development of the technology?

Peter Stone: Well that is one of the beauties of RoboCup, the robot soccer competition, it is sort of a built in benchmark. You can see how your team is doing compared to the other teams around the world. You can see how it's doing especially in the simulation leagues. You can see how it's doing compared to last year's teams.

Those are not the only benchmarks. There have been many challenge problems that have been proposed throughout the years. DARPA has been running grand challenges and challenge events for robotics and for autonomous cars over the years. Then there are landmarks of capabilities like the computer that beat the world champion at the game of Go Twenty years ago in chess. There have been benchmarks against people. There was recently a demonstration of a machine playing poker. There are lots of games that we can test against people's performances. Then there are capabilities like the first time a robot can unload a dishwasher without breaking the dishes and stack them up. When can the first robot fold laundry? But I wouldn't necessarily call them benchmarks as much as milestones.

Cognitive Times: Now, you are a soccer player, and you are a violinist. There are music competitions that are often much more subjectively scored than a sport that would be defined by a set of rules. What do you define as the ultimate milestone? Is it getting to the point where a machine can beat a human in a rules-based competition, or would it be the point where a machine can create music that brings you to tears?

Peter Stone: Beating a human at something is not a challenge anymore.

YOU ARE SEEING THEM ACTING. YOU ARE SEEING THEM BEHAVE. REALLY, YOU ARE PROJECTING ONTO THEM THE CONCEPT OF THINKING.

Machines have been able to beat people at arithmetic for a long time and there are many things that computers are better at than people. I don't think the goal is for computers or robots to be better than people at everything. I don't think that's ever likely to happen. I think that it's better to think of machines as a different species, with different capabilities and different weaknesses. It would be great if there would be a computer that could create a work of art that would be able to bring people to tears. That would be a very nice achievement and milestone. But for me there are a lot of concrete research challenges, things that programs can't do yet that we think they ought to do and ought to be able to do. How can we think about the algorithms that are required to make that happen? One of the exciting things about AI is that it's a moving target in some sense. Once the field achieves a goal, the world sort of stops thinking of that goal as being an "AI thing". There's always the next thing. Some people define the field of AI as the science of getting the computers to do what they can't do yet. And there is always something they can't do yet.

That means that what you were working on ten years ago may not be current anymore. We are not at risk of running out of things to do, so I don't think there is really one challenge. I am inspired by the RoboCup goal of trying to obtain that objective measure of being better than a human at soccer, but that won't be the mark of all intelligence by any stretch.

Cognitive Times: So when we talk about that, there is a view around augmented intelligence that, while AI is getting better, there is the idea that human and machine combos can out perform machines by themselves. Do you see this as a short term situation where some point down the road AI will be able to out perform humans in all capacities, or do you think that human advantage will always outlast machines?

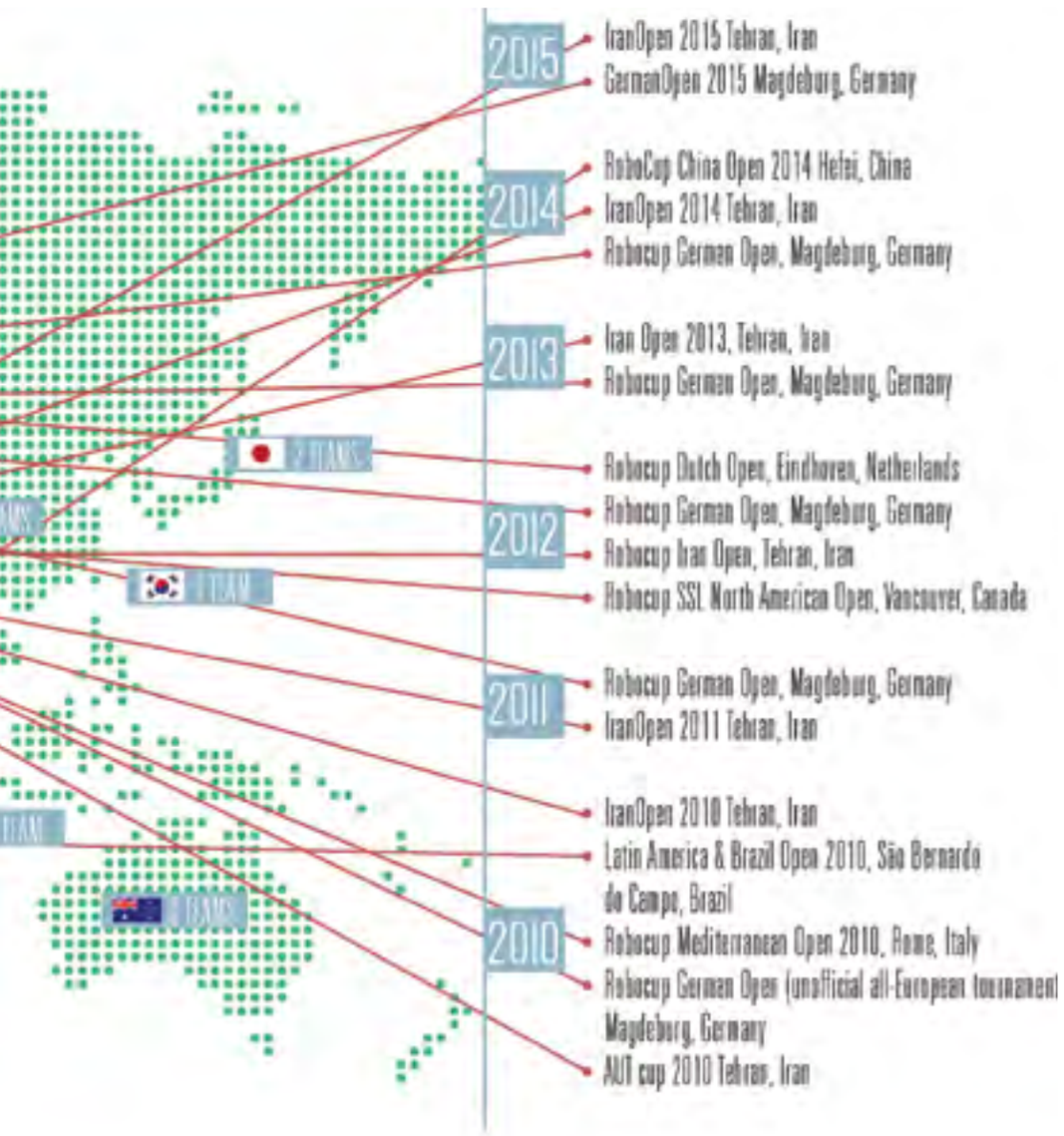
Peter Stone: I think there is always going to be things that are unique to humans. I think that's a long term thing Collaborative systems between robots and people and how machines can augment people is something that's going to be a reality for quite some time.

AI IN SPORTS


25 TEAMS
7 TEAMS
1 TEAM
1 TEAM
2 TEAMS
4 TEAMS
3 TEAMS
1 TEAM
6 TEAMS
4 TEAMS
3 TEAMS
2 TEAMS
3 TEAMS
2 TEAMS
2 TEAMS
1 TEAM
10 TEAMS
8 TEAMS
21 TEAMS
1 TEAM
4 TEAMS
1 TEAM
3 TEAMS
1 TEAM
8 TEAMS
2 TEAMS

All teams in the RoboCup Standard Platform League (SPL) 2014

WE HAVE GOT A LOT OF PEOPLE WITH ENTREPRENEURIAL EXPERIENCE AND A LOT OF REALLY DEEP TECHNICAL EXPERIENCE. I THINK AUSTIN SHOULD AIM TO BE THE CAPITAL IN THIS AREA.



Cognitive Times: Turning to the University of Texas, what are the some other exciting areas that your colleagues are working on, or areas that you see as really advancing to the state of the art in robotics and AI?

Peter Stone: AI is a very broad field, we are actually right now growing in a very exciting way in a broad area that we are calling "machine perception." It includes computer vision and we have one the world's experts in computer vision, Kristen Grauman. We just hired a new young faculty member in computer vision.

Another aspect of perception is natural language understanding and Ray Mooney is one the world's experts in natural language processing. There are also people who have been around in the department for quite some time working on AI in very important areas. Our Chair, Dr. Bruce Porter, has worked in the areas of knowledge representation and reasoning, and he has made some really big contributions that are still ongoing, exciting areas of AI. Some people are sort of pointing towards machine learning as being a thing that can solve everything. I don't think that's true. We need to stay grounded in some

of the logical reasoning that Vladimir Lifschitz does, and in the knowledge representation and reasoning that Bruce Porter does. There are other forms of machine learning. Risto Miikkulainen works in a type of machine learning known as evolutionary computation. Dana Ballard is sort of an interface between psychology and machine learning. Then there is Adam Klivans who works in machine learning theory. I could keep going for a while here. I haven't even talked about more statistical machine learning. AI is a very broad area.

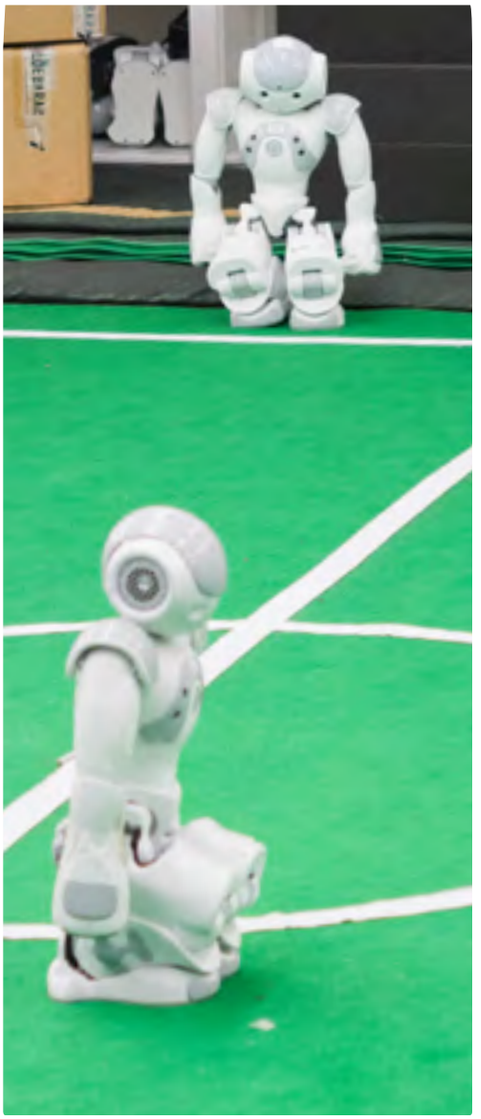
In robotics, there are faculty who are doing very interesting work, sort of related to reinforcement learning, in human robot collaborative systems. They have created a system where the person and the robot worked collaboratively to assemble IKEA furniture, having the robot understand from demonstrations the steps of the tasks that the person was trying to demonstrate. Understanding the impact or the effects of actions in the world is something that many of us are sort of touching up.

Cognitive Times: That's a lot happening on one campus. You're highly regarded academic, you know what's going on, not only in the US, but also globally, and your alma mater is Carnegie Mellon, one of the top schools in the country. You have a good sense of the industry and academic achievement in the field.

There are a number of companies that are focused on machine learning and artificial intelligence here in Austin. As you know our CEO, Amir Husain, has publicly stated our goal of transforming Austin into a hub of innovation for AI. You have a lot of individuals and organizations working to make this goal a reality. Do you see that as an achievable goal here in Austin given the trajectory that we are on now?

Peter Stone: Yeah, absolutely. In fact, I have personally recently founded a company with two colleagues that's focused on exactly the kind of research that I do - learning about the continual effects of actions - continual learning. I have also talked to a lot of people in this area and I think we have a lot of expertise here. There are a lot of PhD students who have graduated from here. There are a lot of masters and undergraduate students who have some experience in artificial intelligence through our classes. I think Austin is one of the best tech hubs. We've got a lot of people with entrepreneurial experience and a lot of really deep technical experience. So yes, I think Austin should aim to be the capital in this area.

Cognitive Times: I know you touched on this specifically for your research group, but taking a macro view of the industry, what do you see as the next big challenge for AI research?



Peter Stone: There is not just one, there are many. There are challenges in computer vision, there are challenges in natural language understanding, moving toward more dialogue based systems. The challenges that I am focused on do pertain to reinforcement learning or understanding the effects of actions, being able to learn the effects of actions, and being able to take the sequential decision- making from that towards real world problems.

Really, this is actually very important. The picture of AI in the media and in the press has always been that it's a series of either huge successes and huge failures. Right now we are in an upswing and so AI is getting lots of positive attention. Inevitably, if history rings true, many of the promises that are being made won't be delivered upon, and then there will be a big crash of disappointed, unmet expectations. Then there will be a trough. Then people will say, "Oh no it's better than that". There's a view that it is all happening in these waves, when really the reality of AI is that, like any other science, it's been a gradual and steady process over the past fifty to sixty years. I think that's going to continue to happen. There will be incremental progress that needs to be made in many different areas from robotics to natural language to knowledge representation. Gradually, as the technologies keep maturing, they can all come together and every once in a while there will be a confluence of data, computation, and techniques that get us to a new level on some benchmark. The public's perception is often that these breakthroughs are sudden, but really they are the result of decades of gradual progress. That's going to continue to happen from the long term perspective of people who have been working in the field for many years. I think that's the way it has always been, and that's the way it will continue to be.

Cognitive Times: Dr. Stone, thank you very much for having us, we really appreciate your time, and best of luck in the upcoming RoboCup.

MACHINE INTELLIGENCE SOFTWARE THAT TRANSFORMS
CUSTOMER ENGAGEMENT AND SCALES EMPLOYEE EXPERTISE

We deliver cognitive applications and processes powered by our Industry Cognitive Clouds. Cognitive applications are a new class of AI powered big data interpretation systems that weave rich experiences, actionable insights, and continuous learning into the fabric of your business.

Customers have radically changed the ways they interact with businesses. We help your business engage online, connected and social customer through practical and scalable machine intelligence to drive transparency, authenticity, and trust.

ENGAGE AND AMPLIFY
YOUR CUSTOMER AND EMPLOYEE EXPERIENCES

PRODUCTS

ENGAGE
Revolutionize Customer Engagement

AMPLIFY
Augment Employee Expertise

INDUSTRIES

COMMERCE
Inspire shoppers with personalized insights and cognitive commerce to improve conversion rates and loyalty.

HEALTHCARE
Improve patient engagement, manage population health to improve outcomes and lower cost of chronic diseases.

FINANCIAL SERVICES
Empower clients and their wealth managers with insights triggered by portfolio changes and market events.

PROVEN TIME TO VALUE

Proven products and services that have been successfully deployed by industry leaders across healthcare, retail, travel, and financial services industries. Our products are trusted by innovative companies who are reimagining work, reimagining engagement models, and reimagining business models.

Entrepreneurs Fund IV and IBM, among others.

Strategic Partners

IBM | Deloitte.