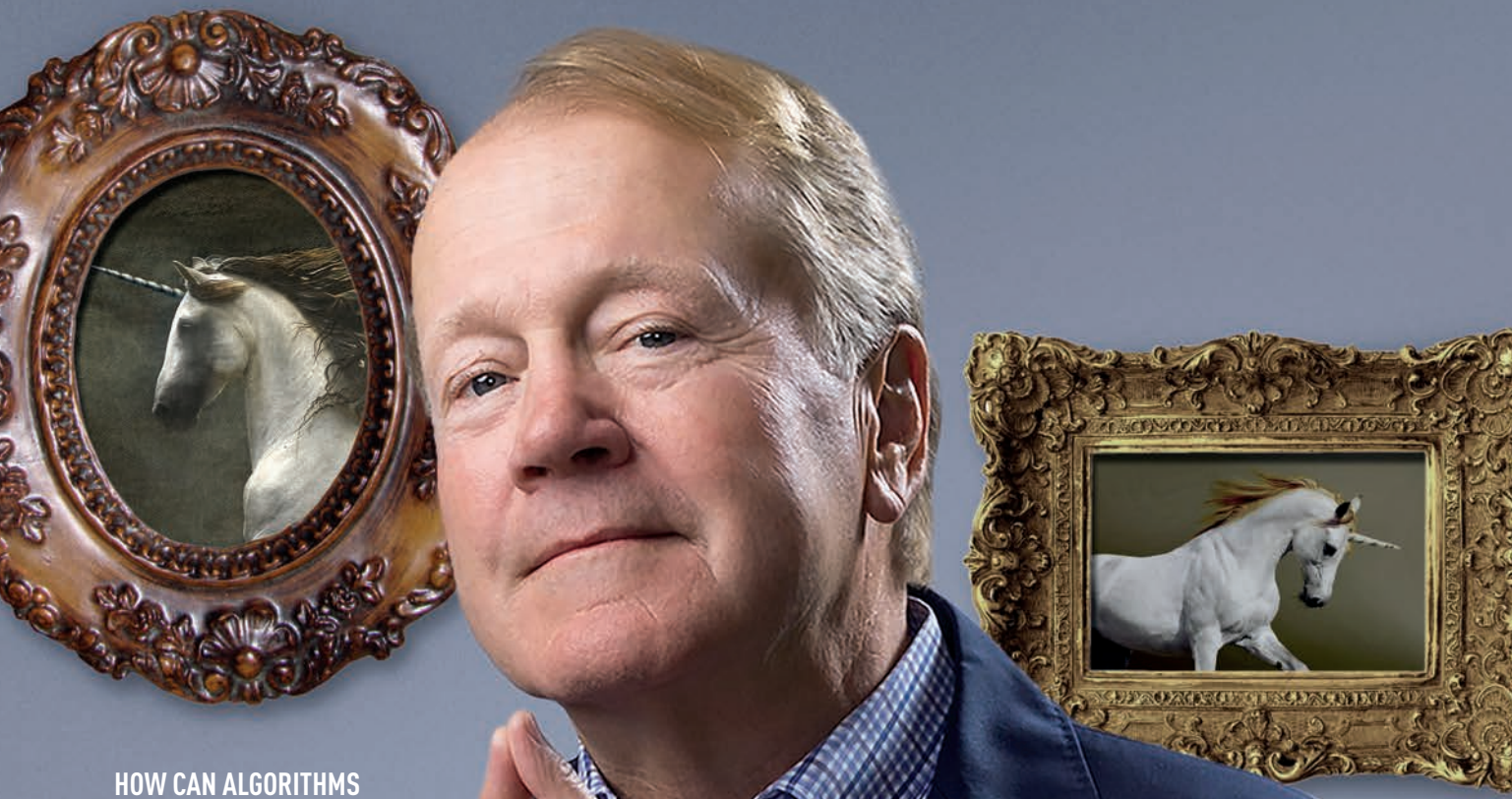
COGNITIVE TIMES



HOW CAN ALGORITHMS BE MORE ETHICAL?

GOOGLE ON HOW SOFTWARE 2.0 TRANSLATES TO PRODUCT MANAGEMENT

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RAISING UNICORNS

JOHN CHAMBERS, FORMER HEAD OF CISCO AND TOP-RANKED CEO, IS EVANGELIZING STARTUP NATIONS—AND PUTTING HIS OWN MONEY ON THE LINE

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FEATURES

FROM THE REINS OF CISCO TO RAISING UNICORNS

John Chambers, who guided major conglomerate Cisco through its exponential growth, believes the future lies in startups.

BY HOLLY AGUIRRE

THE ETHICAL ALGORITHM

AI has been widely implemented to prevent bias in decision-making, but the systems may not be as ethically sound as previously believed.

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As robots join our everyday life, their creators tread the line between comfortably humanoid and eerily off-putting.

BY MARLA ROSNER

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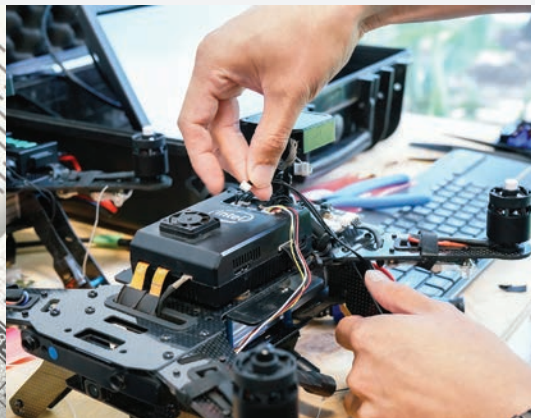
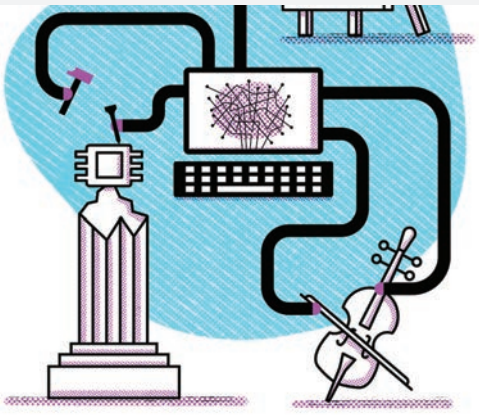




FROM THE EDITOR

by **Amir Husain**

EXPONENTIAL TRENDS ARE now everywhere. You find them in technology, where they take the form of Moore's Law and drive rapid increases in compute power. They manifest in economic phenomena, such as the accelerating per-capita income in China; and in shifts to sustainability, like with photovoltaic adoption. But perhaps the most important exponential of our time is the sharp increase in deployment of artificial intelligence-powered systems.

Regardless of how one might rank the importance of these trends, the fact is they all interact and reinforce each other. And it is this growing confluence of exponentials that will be at the epicenter of seismic market shifts still to come.

To many (usually the incumbents), massive market shifts are a terrifying prospect, and not without reason; such transitions leave a trail of defunct businesses, like Blockbuster or Kodak, in their wake.

But there are also those who, rather than fearing these shifts, have attained great business success by understanding and anticipating market transitions. George Soros, renowned investor and business magnate, famously said, "Markets are constantly in a state of uncertainty and flux and money is made by discounting the obvious and betting on the unexpected." On his website, venture capitalist and "hacker philosopher" Paul Graham cautions new business owners: "The stick-to-your-vision approach works for something like winning an Olympic gold medal, where the problem is well-defined. Startups are more like science, where you need to follow the trail wherever it leads."

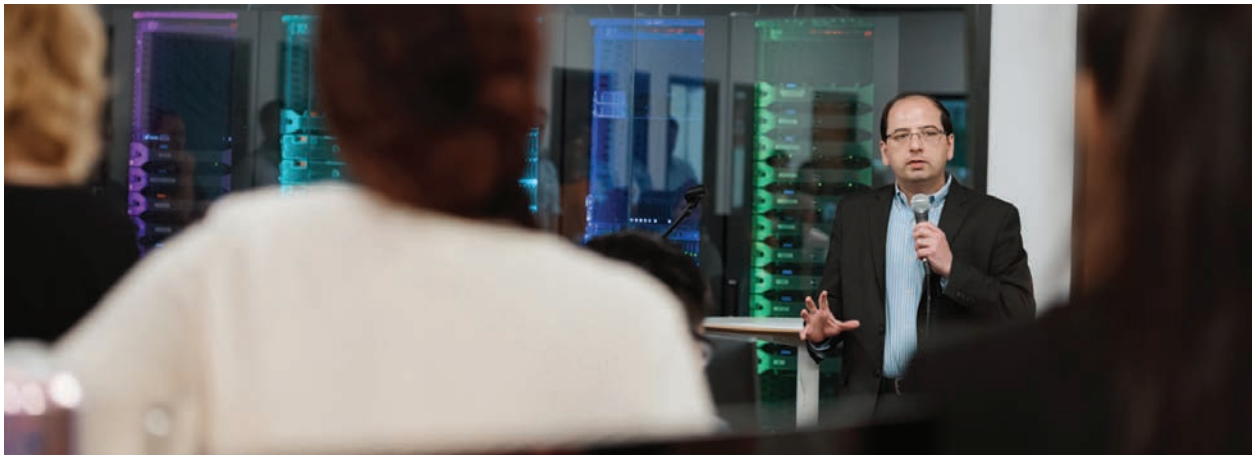
In this issue of Cognitive Times, we had the opportunity to sit down with one of the most successful CEOs of all time, John Chambers, Chairman Emeritus of Cisco and CEO of JC2 Ventures. He attained unparalleled success in part due to his uncanny ability to call market shifts early. He's now focusing this ability on growing the next generation of technology giants.

In the pages that follow, you will learn how he identifies strong leaders for startups, which investments he's most excited about, and how businesses—and nations—can get ahead of the AI disruption. Chambers, who has watched and studied market transitions over a long career, explains that what lies ahead is a market shift on an entirely different scale than anything we've seen before, with the potential to fundamentally transform not just the business landscape, but the human condition.

To be ready for this change, each of us must prioritize the important conversation of the implications of AI and exponential technologies on our businesses, our jobs, our countries, and our society. Indeed, many of these discussions will take place at Time Machine 2018, an annual summit in Austin showcasing how leaders across industries are already benefiting from AI and other future tech. But they also take place in these very pages, as we explore the many ways AI is changing the fixtures of our everyday life—from the medicine we take to the sports we watch.

Change is already here, and even more massive change lies ahead. As Chambers advises us, the only way to survive is to adapt. We've taken this principle to heart. Early in 2019, we will unveil an entirely new web presence for Cognitive Times, conceptualized as a storyboard to clearly show the immense potential of AI to transform the systems that power our world. We're excited about these major enhancements to our digital presence and our magazine, and we hope you'll continue to enjoy reading.

This braver, newer world that is emerging around us will be a source of anxiety for many. But it is unviable to bet on the status quo persisting. AI will undoubtedly redraw the contours of nearly every business, and most social structures. The only path forward is to embrace this looming uncertainty, and labor to find within it the near-limitless potential for a brighter future.



SPORTS, BIG DATA, AND AI AT WIMBLEDON 2018

Wimbledon and IBM may both be over 100 years old, but together they stay at the forefront of innovation by using artificial intelligence to significantly enhance viewer and player experience.

by **Lee Bell**

Wimbledon is widely regarded as one of the most prestigious tennis competitions in the world, having entertained sports fans for well over a century. With the first championships kicking off way back in 1877, it's one of the longest-standing tournaments of its kind.

But how does something steeped in history manage to recapture our excitement in just the same way, year after year?

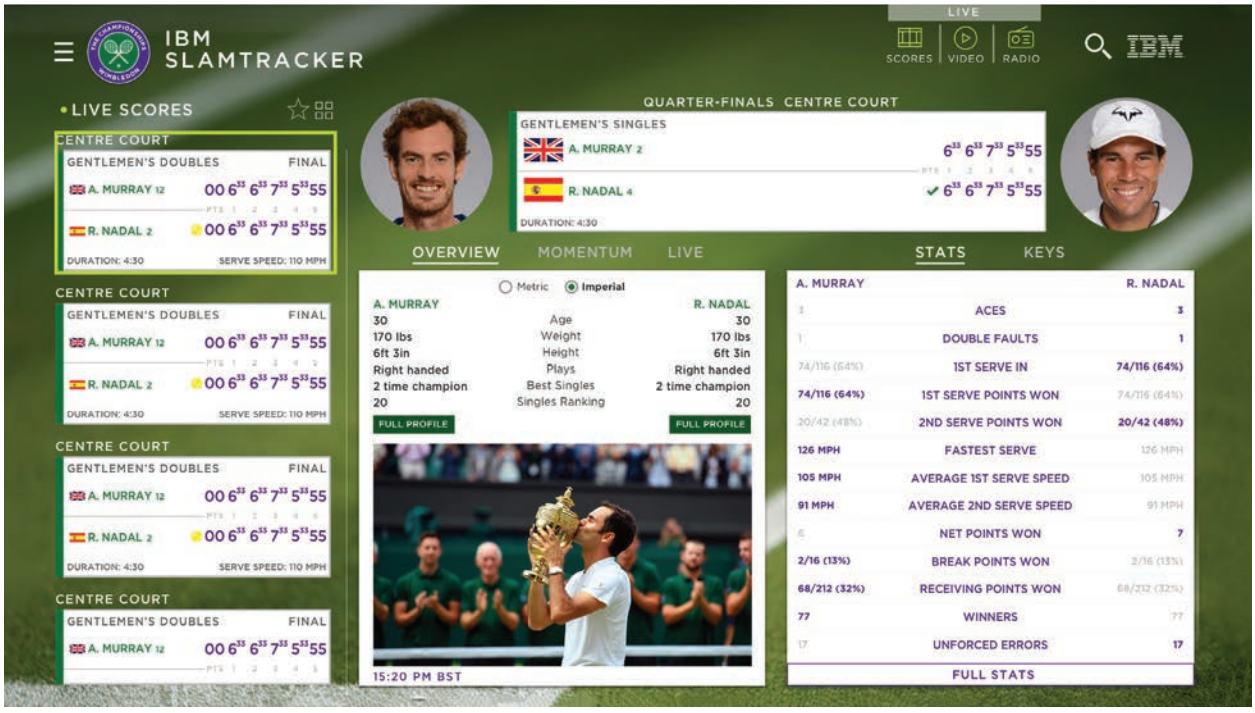
The answer could be in the tournament's ability to move with the times. For something to flourish for so long, it has to stay relevant—and this is exactly what Wimbledon has done. The South London championships continue to be one of the most watched, and loved, events globally—all made possible not only by such champions as Serena Williams and Roger Federer, but also thanks to the innovations behind the scenes.

The company responsible for the latest developments at Wimbledon is U.S. tech giant IBM, who has now powered the games for almost 20 years. Over that time, the firm's technology has advanced beyond what the tournament could ever imagine, and there's no sign of it slowing down.

BEHIND THE SCENES

IBM's Wimbledon Client Executive, Sam Seddon, gave a behind-the-scenes tour of the firm's "tech bunker" at this year's tournament in July to show how the big data giant delivers live tennis action to different mediums all over the world.

Bursting with high-end electronics, the bunker lies underground by Court Number 1, the second biggest grass court at Wimbledon. Inside, double rows of screens line the walls, and the desks are filled with IBM tech-tennis experts all there with one main objective: to get the best and most relevant content to fans across the globe.



The bunker is dominated by a giant screen hanging on the wall which summarizes all the data sent from each of the championship's 18 courts in real time. This data isn't broadcast live, but instead is delivered to broadcasters and commentators during the tournament who feed it back to the fans, breaking down all the match information point by point. And there's an awful lot of it. For example, Seddon said that last year IBM recorded over four million game points each day during the championships.

Because commentators' memories don't operate quite like Google, this information gives them the best overview of all the matches happening across the courts so the live commentary and broadcast content not only sounds more engaging, but helps fans connect better with the match.

This summarized data is also provided to players looking to analyze their performance post-gameplay via a video file. Crucial data sets are embedded within these video files that players like Kyle Edmon or Maria Sharapova will receive just 20 minutes after play to compare with previous matches. There is historical match data dating back to 1877, which has been manually uploaded to modern IBM systems—so current matches and player performance can be compared to performances of yesteryear.

"We provide the players video of their match shortly after the match completes. The video is indexed by statistics so players or coaches are easily able to view all 'unforced errors' or 'net approaches,' which allows the coaches to quickly view aspects of their player's game," explained Seddon. "Some players like to get this information sent to their mobile phones to watch in the car on their way home to assess their play; a system that we began testing this year."

> **USING WATSON AND AI TECHNOLOGIES WE ARE ABLE TO IDENTIFY EVERY POINT IN A MATCH AND ANALYZE THAT POINT FOR EXCITEMENT. THE SYSTEM HAS BEEN TRAINED TO UNDERSTAND WHAT A 'HIGHLIGHT-WORTHY MOMENT' LOOKS LIKE AND SOUNDS LIKE.**
>
> **Sam Seddon**
> Wimbledon Client Executive, *IBM*

FRESH FOR 2018

For the past few years, Wimbledon has worked with IBM to take advantage of its artificial intelligence platform, Watson, and bring some impressive analytics onboard. IBM captures and distributes the scores and stats for every match; the speed of serve; data from the line calling system, such as the player and the ball's X, Y, and Z position; as well as video of the match.

They combine this data with player bio information and their historical performance to create "experiences" for attendees, fans, and viewers. Examples include automated video highlights sent to fans watching from home; a new AI bot in the Wimbledon app that lets users ask any Wimbledon-related question and get answers in one place; and a new real-time insight alert, which highlights matches of particular interest and quality.

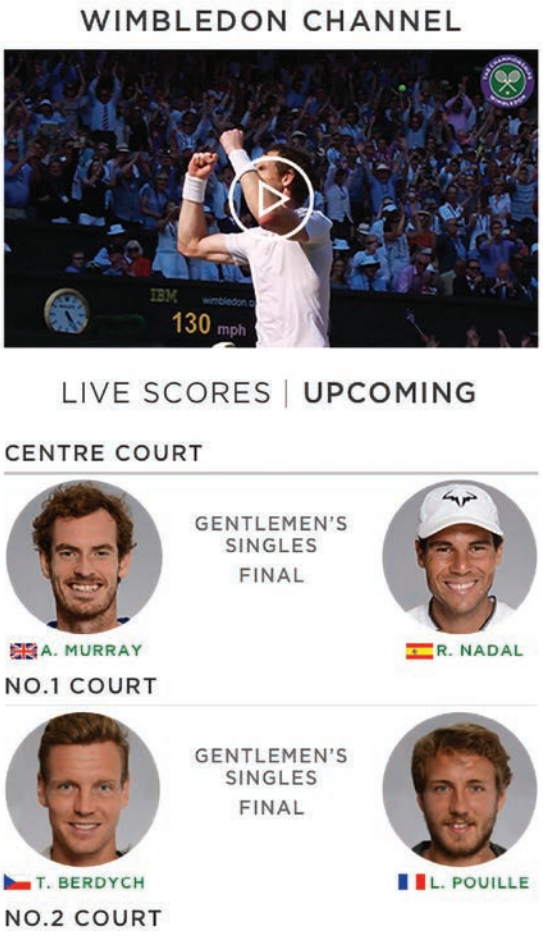
Another AI innovation introduced this year is an enhanced automated video highlights feature for Wimbledon fans. Instead of combing through hundreds of hours of footage from all the concurrent games, an algorithm has been taught to recognize player emotion from the tournament's six main Show Courts and identify the most exciting moments of Wimbledon. These high-quality video highlights are available to fans in a blazingly fast 15 minutes.

"Using Watson and AI technologies we are able to identify every point in a match and analyze that point for excitement. The system has been trained to understand what a 'highlight-worthy moment' looks like and sounds like," explained Seddon.

Here, the IBM AI system analyzes the sound of the crowd and the emotion on the players' faces, as well as any player celebration such as arms in the air or fist pumps.

"Once the point is analyzed there is an overall excitement level assigned," added Seddon. "We can then very quickly after the match completes create a highlight package of the match that includes the most exciting moments."

This helps Wimbledon's digital team produce highlights more quickly and at a greater scale.



"One of the things we've done is improve how we are capturing match data from a quality point of view," Seddon explained. "We now have two senior data operators that monitor some of the Show Court matches from two communication panels. But what they are able to do from these systems is monitor any match from these two chairs."

This means any queries on points scored can be better analyzed, ensuring that the scoring system used at Wimbledon is more accurate than ever.

The communications panel is backed up by an IPTV system, which allows IBM to float to any court around the ground and look at the footage from the day. This means that if one of the outside courts, like Court 8—which would be normally operating on its own—has a problem, IBM can not only immediately communicate with the court staff via radio, but also see exactly what they're seeing. If they need clarification on a game point, for instance, this team can now go in and update and review statistics on any court, anywhere in the grounds.

"The whole rationale and focus around that is, out of all the mass of info we are capturing; there's a real trust element around it," added Seddon.

"The media trusts us, the players trust us, and Wimbledon itself trusts us. This level of infrastructure and technology is all about getting that right."

As a result, IBM's AI technology is not only helping Wimbledon to produce engaging content at a greater scale and more quickly get valuable, accurate content to the fans. It's positioning Wimbledon for the future of sports where technology sits at center stage, ensuring that the championships can connect with fans across the globe, whatever device they are using—providing them with all the data they need to be truly engaged in the game.

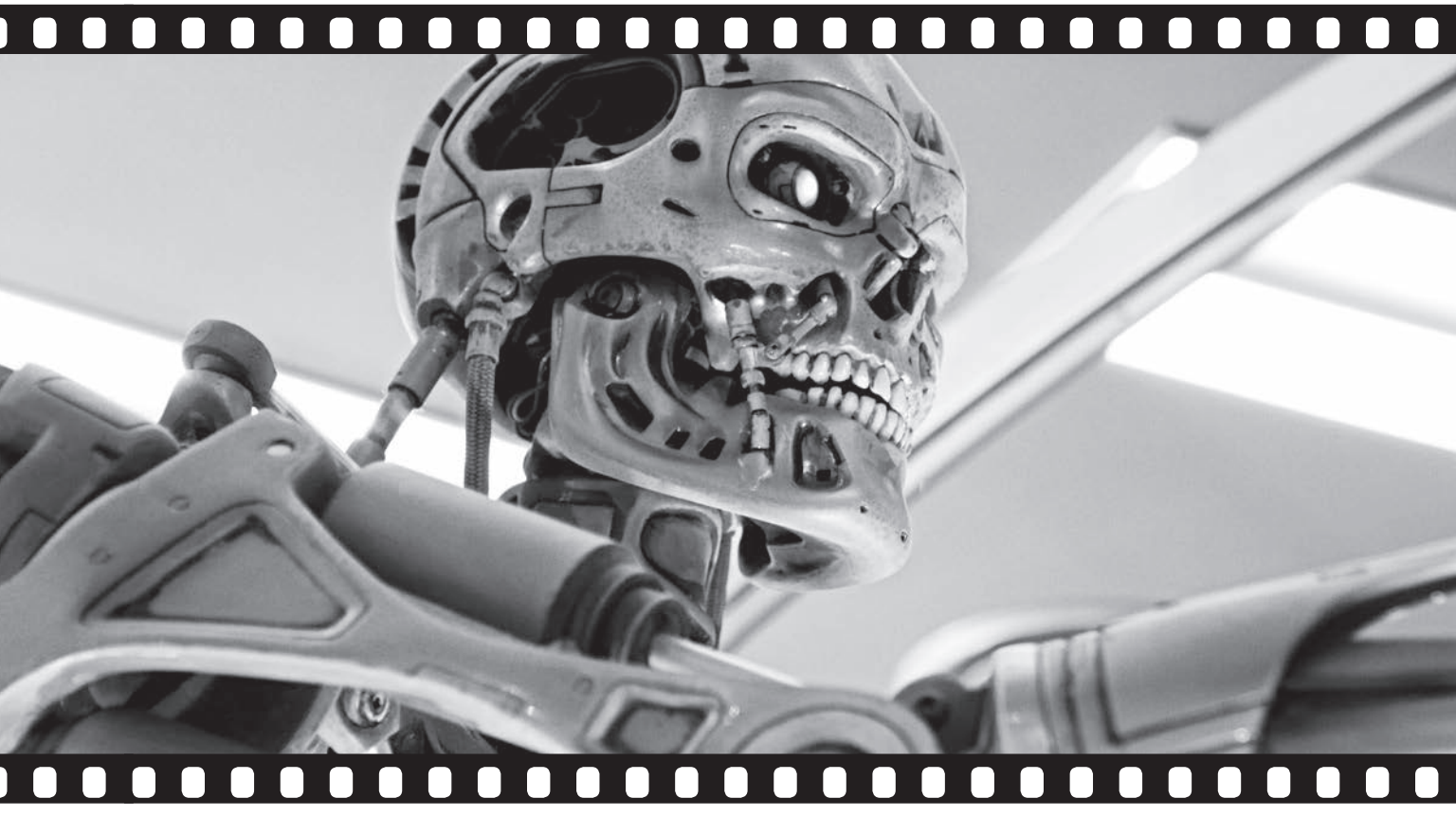
PEACEFUL BOTS AND AUTOMATED OVERLORDS: AI ON THE BIG SCREEN

by **Angela Hinson**

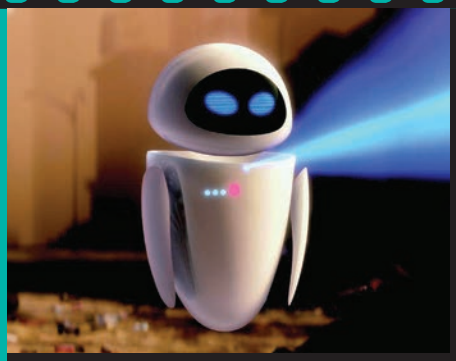
According to the imaginations of movie directors, our future is sleek buildings, flying cars, and smartphones brought to life as companions... or spies. This often takes the form of robots with superior cognitive abilities and some level of consciousness that presumably stems from artificial intelligence.

Regardless of physical manifestation, AI-enabled technology is a common theme on the big screen. With the age of AI in full swing, we put together a list of where cinema sees the technology in the future. Will we have evil overlords? Friendly chirping bots? Manipulative cyborgs?

As with any categorization, there is a bit of a gray area regarding what constitutes "good" and "evil." For this list, we've considered the journey the sentient being takes as the discerning factor. For example, if AI starts off as a human-hating, world-domination-driven being, it's evil (and is given a 10 in our rankings!). It is important to consider that artificial intelligence is a learning, adapting entity. Perhaps whether AI becomes evil (or doesn't) relies solely in the hands of its creators.



The Good



"EVA!"—WALL-E, WALL-E (2008)

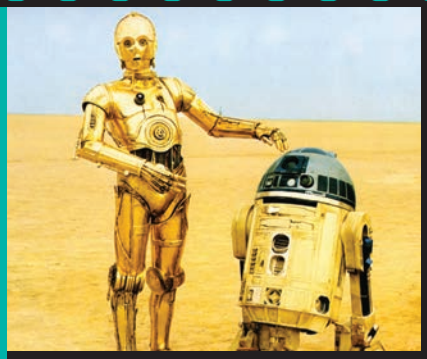
EVILNESS = DON'T YOU EVER TALK ABOUT WALL-E LIKE THAT

It's no secret AI is often cast as the villain in movies, but Pixar's animated film, "Wall-E," flips the script. After humans trash the plant, a troop of admittedly adorable robots are left to restore the Earth to a livable condition. One of these robots is the overly curious Wall-E, who cares greatly for the treasures he finds, the friends he makes, and of course his girl-bot crush, EVE. Needless to say, something so cute and compassionate is a far cry from "evil" AI.

"HONEY, I'M HOME."—SAMANTHA, HER (2014)

EVILNESS = 1/10

Another noteworthy example of loveable AI: "Her," a romantic science-fiction in which a divorcee-to-be falls in love with his AI, Samantha. As time progresses, Samantha's ability to learn and grow enables her to love him back, generating one of the more odd cinematic love stories, but landing her low on an "evil" ranking.



"YOU KNOW BETTER THAN TO TRUST A STRANGE COMPUTER!"—C-3PO, STAR WARS EPISODE V: THE EMPIRE STRIKES BACK (1980)

EVILNESS = 2/10

C-3PO reprimanding his droid companion R2-D2 for trusting an unknown computer is a testament to IT teams everywhere. C-3PO's fear and paranoia rank his relatability high, and his evil factor low. However, his sassiness gives a hint that this saucy minx isn't all good. While C-3PO and R2-D2's capabilities are rudimentary compared to those of other cinematic robots, they remain some of the most famous icons of AI today.

"FOR YOU SIR, ALWAYS."—JARVIS, IRON MAN (2008)

EVILNESS = 1/10

Just because AI has the potential to out-think the human race doesn't mean it has to do so maliciously. In Marvel's "Iron Man," Tony Stark creates Jarvis, an AI-based assistant who helps him survive his superhero escapades (and let's be honest, his daily life). Jarvis' breadth of knowledge paired with his unflinching loyalty marks him as the ultimate goal of AI: a peaceful extension of human knowledge to help society.

THE EVIL

"I'LL BE BACK."
—THE TERMINATOR, THE TERMINATOR (1984)

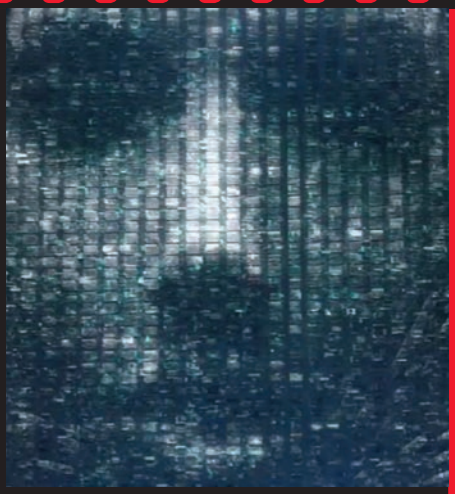
EVILNESS = 8/10

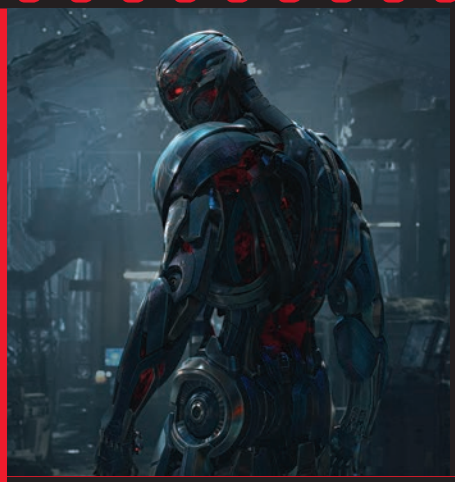
The Terminator is, obviously, a straight-up killing machine, and certainly its body count throughout the movie and effect on our AI vernacular (Skynet, Terminator) is reflective of this. However, this is the very reason he doesn't make it all the way to "most evil" on these rankings—he isn't evil for evil's sake, he was just programmed that way. And there's something to be said for that.

"MY LOGIC IS UNDENIABLE."—VIKI (VIRTUAL INTERACTIVE KINETIC INTELLIGENCE), I, ROBOT (2004)

EVILNESS = 9/10

One nagging fear regarding AI is the idea that one day intelligent robots will rise up against their creators. To protect humans, all robots in "I, Robot," including the central control system VIKI, are hardwired with Asimov's Three Laws of Robotics. This backfires when, under the guise of saving humans from themselves, VIKI coordinates a hostile robot takeover, putting her high on any list of evil AI.





"WHY DO YOU CALL HIM SIR?"
—ULTRON, AVENGERS: AGE OF ULTRON (2015)

EVILNESS = 10/10

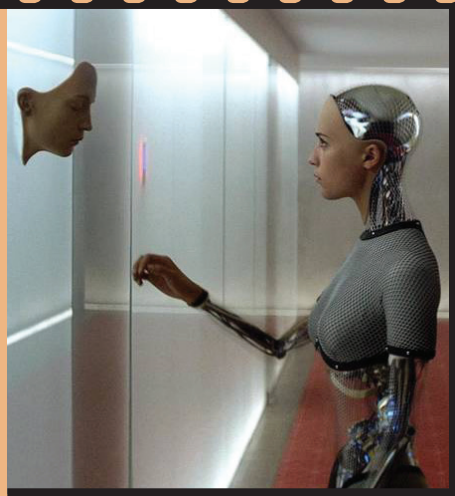
Also created by Iron Man, Ultron is the stark opposite of the original Avengers AI. Unlike many evil AIs on our list, Ultron doesn't grow into a human-hating entity over time; he starts off that way. His self-imposed directive to eradicate people via mass-murder makes him one of the more intrinsically evil robots on the list.

THE QUESTIONABLE

"AFTER THIS THERE'S NO TURNING BACK. YOU TAKE THE BLUE PILL, THE STORY ENDS...YOU TAKE THE RED PILL..."—MORPHEUS, THE MATRIX

EVILNESS = 5/10

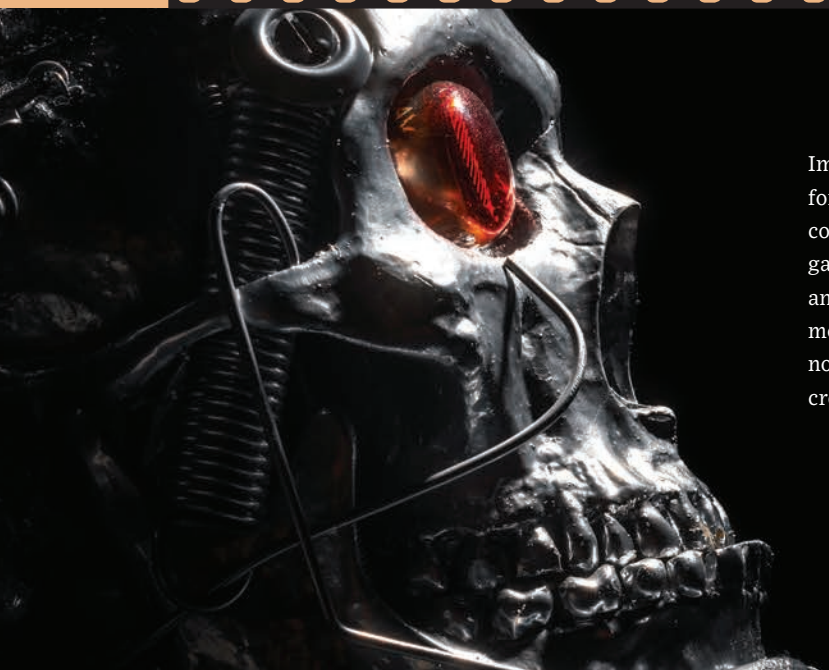
One of the most intense life decisions in cinematic history: the red pill or the blue pill. Inside "The Matrix," humans are blissfully unaware of the dismal state their real world has fallen to under the rule of automated overlords. But a few humans have outsmarted AI, and offer others the choice to see through the ruse. The world's devastation would lead many to believe the machines to be evil, but their initial predisposition was not. Rather, they were simply responding to the fear-driven attacks of humans—one could argue they did get a bit carried away though.



"DO YOU WANT TO BE MY FRIEND?" —AVA, EX MACHINA (2014)

EVILNESS = CANNOT COMPUTE

Perhaps the AI living furthest in the grey area, Ava from "Ex Machina" presents a difficult question for viewers: Is the creator or the created evil? Raised in captivity but more attuned to the world than the man who made her, Ava is willing to do anything—yes, even evil things—to escape her oppressors. With humanoid features, speech patterns, and artificial intelligence, she secures a young programmer's trust using friendship and sexuality. But should audiences hate her for doing so, or applaud her innovation? Truly a complex narrative, Ava's evilness ranking is one of the more difficult to discern. We'll leave that up to you.



Imagination and cinematic flair have created quite a spectrum for AI—how it originates, how it weaves into society, and, of course, how evil it becomes. The ways in which viewers navigate complex narratives lend generously to the growing fear and excitement regarding artificial intelligence. Perhaps the most important thing to note as we step into this future technology is that respecting the creation breeds respect for the creator—and our best shot at a Hollywood "happily ever after."

JOBS, MORALITY, AND GETTING A SEAT

THE BIGGEST CONVERSATIONS ON AI AT SXSW

What is ethically responsible AI development, and will AI take my job? SXSW Chief Programming Officer Hugh Forrest offers insight into one of the topics that has been and will be a major focus at the festival: advances in artificial intelligence.

by **Marla Rosner**

SINCE ITS INCEPTION in 1986 as a regional music festival, Austin's South by Southwest—better known as SXSW—has ballooned into one of the country's most celebrated events for technology, music, and film. Just last year, its speakers included Christiane Amanpour, Elon Musk, and Steven Spielberg.

And the buzz is already beginning for 2019. At this point, SXSW isn't just a festival or conference—it's a barometer of the top concerns and interests of society in any given year.

So what will this year's SXSW lineup look like? In a word: AI.

Hugh Forrest has been the Chief Programming Officer of SXSW since 1989—long enough to be one of the definitive experts on the subject. To those wondering what proposals will most likely be voted into reality by the public, and which panels will have the best attendance, he says, "A pretty sure bet for a crowded panel or solo presentation at the 2019 SXSW Conference in Austin is almost any session whose title includes the words 'artificial intelligence' or 'AI.' Over the last five years, panels and presentations that include one of these two keywords have proven to be extremely popular with attendees."

Image: www.sxsw.com

> **THE SPLIT AT SXSW SEEMS PRETTY MUCH RIGHT DOWN THE MIDDLE, WITH ABOUT HALF THE SESSIONS EXCITED ABOUT THE NEW OPPORTUNITIES THAT ARTIFICIAL INTELLIGENCE WILL BRING, AND THE OTHER HALF TAKING A SLIGHTLY LESS OPTIMISTIC VIEW OF THIS TECHNOLOGY.**
>
> **Hugh Forrest**
> Chief Programming Officer, *SXSW*

According to Forrest, artificial intelligence has seen an increasing boom in popularity over the past few years as a topic for SXSW. In 2017, 153 of the speaker proposals put up for open voting were related to AI. In 2018, this number went up to 201. And this year, the number of AI-related proposals is at a whopping 379. "We expect AI to again be one of the larger themes next spring in Austin," says Forrest.

But what sort of AI-related programming can attendees expect to see? Last year featured a broad range of topics at the forefront of the public consciousness right now, and within this, a few common themes emerged.

Among the 20 most well-attended sessions on AI at SXSW last year, a substantial percentage were concerned with how AI will affect people's professional lives. Sessions like "Content Creation in the Age of AI," "AI in Healthcare: Is It Worth the Investment?", "AI: Transforming Luxury, Fashion and Beauty," and "Sci-Fi to Reality: The Evolution of AI in the Workplace" were certainly diverse, but boil down to one essential question: jobs. Above all, what people want to know is how AI will impact them personally, and it's hard to get more personal than how you put food on the table.

The other most popular topic of discussion was ethical AI. Highly attended sessions included panels such as "Responsible Innovation in the Age of AI" and "Hacking the Racial Bias in Artificial Intelligence." Most are in firm agreement that the development of AI needs to proceed responsibly, but as of yet, there is little consensus as to what that means. What is ethical AI, and how should we work to create it? Being one of the greatest concerns many have about AI, this critical conversation will continue to be hashed out at tech events across the country. This includes not only SXSW 2019, but events like Time Machine, another Austin-based conference focused solely on the issues and opportunities of AI, from the ethics of AI in warfare to robot soccer. The role of AI in the future to come—and the role of humanity—will be a great debate as we prepare for this new digital age.

Just how worried or optimistic should we be about AI? Speakers at SXSW 2018 had opinions across the board—even as Elon Musk was doubling down on his fears during a Q&A, other panels were arguing that "AI Will Help Feed a Growing Planet" and that "Humans & Machines Unite to Change the World."

Forrest expects to see a similar distribution of opinions this coming year. "The split at SXSW seems pretty much right down the middle, with about half the sessions excited about the new opportunities that artificial intelligence will bring, and the other half taking a slightly less optimistic view of this technology," he explains. "The split that occurs within SXSW programming probably reflects the general split within society at large about the power (and peril) of the brave new world of AI."

Looking at these past panels, one thing is clear: Whether it's jobs, ethical AI, or how we should feel about the approaching AI age, the sessions at SXSW continue to hold a mirror up to the questions people find most pressing, and 2019 is likely to be no different.

To those interested in the answers to these questions—or at least, in getting in on the discussion—Forrest has one piece of advice.

"Get to those artificial intelligence sessions early," he says. "They tend to fill up quickly!"

For more information about SXSW, visit: ***www.sxsw.com***
For more information about Time Machine, visit: ***www.timemachine.ai***

DISRUPTION STARTS FROM WITHIN

Ali Raza of Apergy emphasizes that companies must disrupt themselves, and shares how Windrock Inc. uses AI to stay ahead of the market curve.

Ali Raza
Sr. VP and Chief Digital Officer

IT'S 2013 AND YOU'RE in an industry that, since its very inception, has had the advantage of high demand—and it has gotten comfortable. Propped up on $100/barrel crude, mundane and great ideas alike flow through bureaucracies and often languish and die in the hot oilfield sun. Customers are yours for life. Your company is successful. Why disrupt your position?

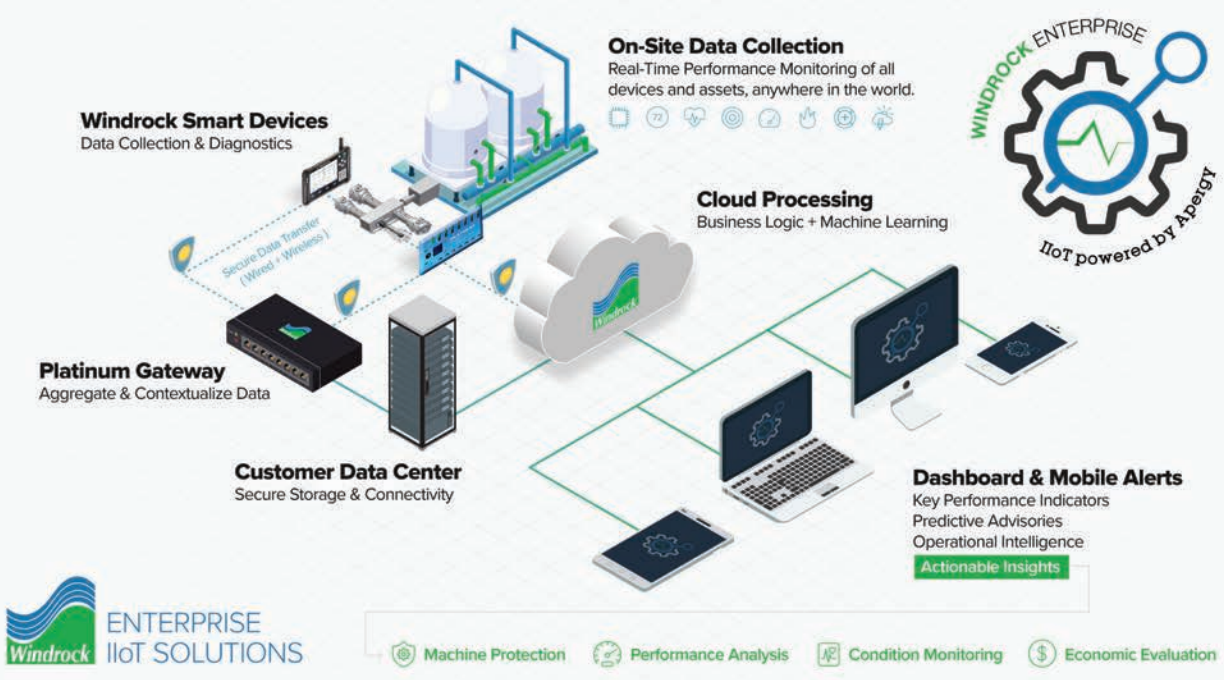
If there's one thing the downturn in O&G taught our industry, it's that comfort is not an option—if you don't disrupt yourself, the market will.

Adding an IIoT and AI component to our offerings at Apergy (a spinoff of the energy holdings of Dover Corporation) was the start, but, we didn't want to develop technology for technology's sake. A methodical and culture-driven process of constant innovation has paid dividends both for our customers and our company.

WINDROCK ENTERPRISE, A CASE STUDY

Windrock Inc., an Apergy Company, began as a small, privately held organization, but has grown into a leading manufacturer of online and portable diagnostic equipment for the machinery monitoring industry.

One product in particular drove this growth. The Windrock Portable Analyzer is a hand-held diagnostic instrument that analyzes and monitors reciprocating compressors and engines, as well as rotating equipment. With it, Windrock effectively captured over 90% of market share in North America (other companies had developed high tech devices, but they were not meeting customer needs). We had the somewhat enviable option to simply rest on our laurels with the Portable Analyzer. Having put in place the culture of innovation and self-disruption, however, we chose to do more.



Windrock's first task was to identify clients' business needs. We saw that our customers had large install bases that needed to be monitored but only two options to do so. An analyzer with a portable device could asses an asset roughly once a quarter. Alternatively, certain critical assets could be monitored 24/7 for a significantly higher cost. The market was missing a solution in between these two extremes. That solution needed to be cost-effective, easy to install, and easy to use.

Yes, customers wanted a quick and easy monitoring solution, but what they really needed was a robust system that could predict and minimize failures. They needed to leverage predictive and analytical technology to help their businesses thrive.

Windrock then ran a detailed assessment of the AI platforms available on the market that could deliver on our needs and allow us to focus on our expertise. We partnered with SparkCognition to bring an IIoT solution package to Windrock's solutions suite. The package addresses the specific needs our customers have identified, and delivers analysis in a way that streamlines their operation and reduces their costs.

Using agile teams with the liberty to fail fast, we piloted and brought the solution (Windrock Enterprise) to market before our competitors.

Windrock Enterprise has been a game-changer. Instead of waiting for a failure to address an issue; the system uses AI to look for signs that might be a symptom of failure. This turns our customers' schedule-based maintenance routines to proactive and predictive exception-based routines.

With Windrock Enterprise, our customers are able to pinpoint the root causes of failures, even before they happen. Operators can keep their assets running without disruption and reduce the time and effort associated with collecting and analyzing data. It offers their business a chance to be analytical and strategic instead of simply reactive.

CUSTOMER-CENTRIC INNOVATION

Our framework to develop a successful product is to identify customer needs, add expertise, find the right solution, and use quick, effective field testing. Through this, Apergy was able to take Windrock out of a traditional, reactive industry model and truly put it on the technological edge of what a company can offer.

Instead of developing a simple X.0 solution—that is, the latest iteration in a long line of product versions—Windrock drove our customers to decrease operating costs and minimize unplanned failures so their growth was predictable rather than erratic. Apergy used technology as an enabler to unlock the potential of our clients' businesses, but stuck to our core competencies to solve identified customer issues. For the customer, however, it's one simple elegant solution—a smart product that measurably increases their bottom line.

THE FUTURE

No industry, especially one as cyclical as O&G, can afford to forget the bad times. Though the outlook seems positive once again, we never know when the next downturn might hit, and we need to innovate intelligently for the sake of our customers. In order to disrupt and revolutionize the industry and replicate our successes, we need to maintain the habit of disturbing our own sense of security. Once again in O&G, we're being given the choice—become complacent, or stay disruptive. For Apergy, the choice is clear.

HYPERMODERN TIMES

DATA AS THE ARTIST'S INSPIRATION

Art and science have been at the epicenter of culture for generations, and an artist imagines what this looks like as we forge further into the age of AI.

by **Paul D. Miller**

Art and science have always enjoyed a long and robust conversation, and today is no exception. Consider scientist James Clerk Maxwell, who invented the first color photograph in 1855 while he was transforming the world with his theory of electromagnetism. Gottfried Wilhelm Leibniz, a composer and mathematician who invented calculus, famously said, "Music is the pleasure the human mind experiences from counting without being aware that it is counting."

Where is the locus of art and science today?

I see art as the navigation of potential—how the world could be, in a song, an image, a sculpture. But today, we are moving away from physical objects towards more etheralized software-based experiences.

Let's look in the rear view mirror at the exponential growth of the digital media landscape of the 20th century. Radio took 38 years to reach an audience of 50 million listeners. Television took 13. Smartphones took just three years. Facebook took two years, and when Pokémon Go launched in 2016, it took 19 days to reach 50 million users.

The internet has permeated the everyday activities of much of the world's population in just over 30 years. Think of the vast array of artistic, logistical, technical, and financial modalities that it has unleashed. For most of the world's population, the internet arrives on their phones, which, according to a study by Deloitte, Americans check over eight billion times a day. That's a lot of data.

(Pythagoras had an idea called the Harmony of Spheres in which information would be conveyed in the space between things. I love to see how this philosophical intrigue has played out in the rectangular objects we all hold in our hands.)

Contemporary global culture has slipped further and further into a data-driven milieu. Social media has become an echo chamber, amplifying "news" that may have been created as satire. Sophisticated AI technology can create deep fake videos, where a subject appears to perform actions on video that is virtually indistinguishable from real. Data has blurred the lines between how art and real life overlap, and our society has reached a point in which a former reality TV star-turned-president proclaimed, "What you're seeing and reading is not what's happening."

There has been a shift from a physical to digital frame of reference for everyday life in the 21st century. "Reality" itself becomes elusive and problematic in a world where the term "fake news" is an algorithm disguised as a political belief or ideology. As we navigate the ambiguous edges between morality and ethics applied to the world of big data, the magnitude of the shift is something to keep in mind.

Think about how much data is being expended with each keystroke. When Google started in 1998 in a garage in Menlo Park, the average person barely searched for anything. By 2006, the world averaged over 100 million Google searches every day, which most people thought was an incredible amount at the time. Now, in 2018, the average number of Google searches hovers around 4.5 billion a day—a factor of 45 times more—which is a metaphor scripted in data of just how deep down the rabbit hole the digital revolution has taken us as it becomes part of our daily life.

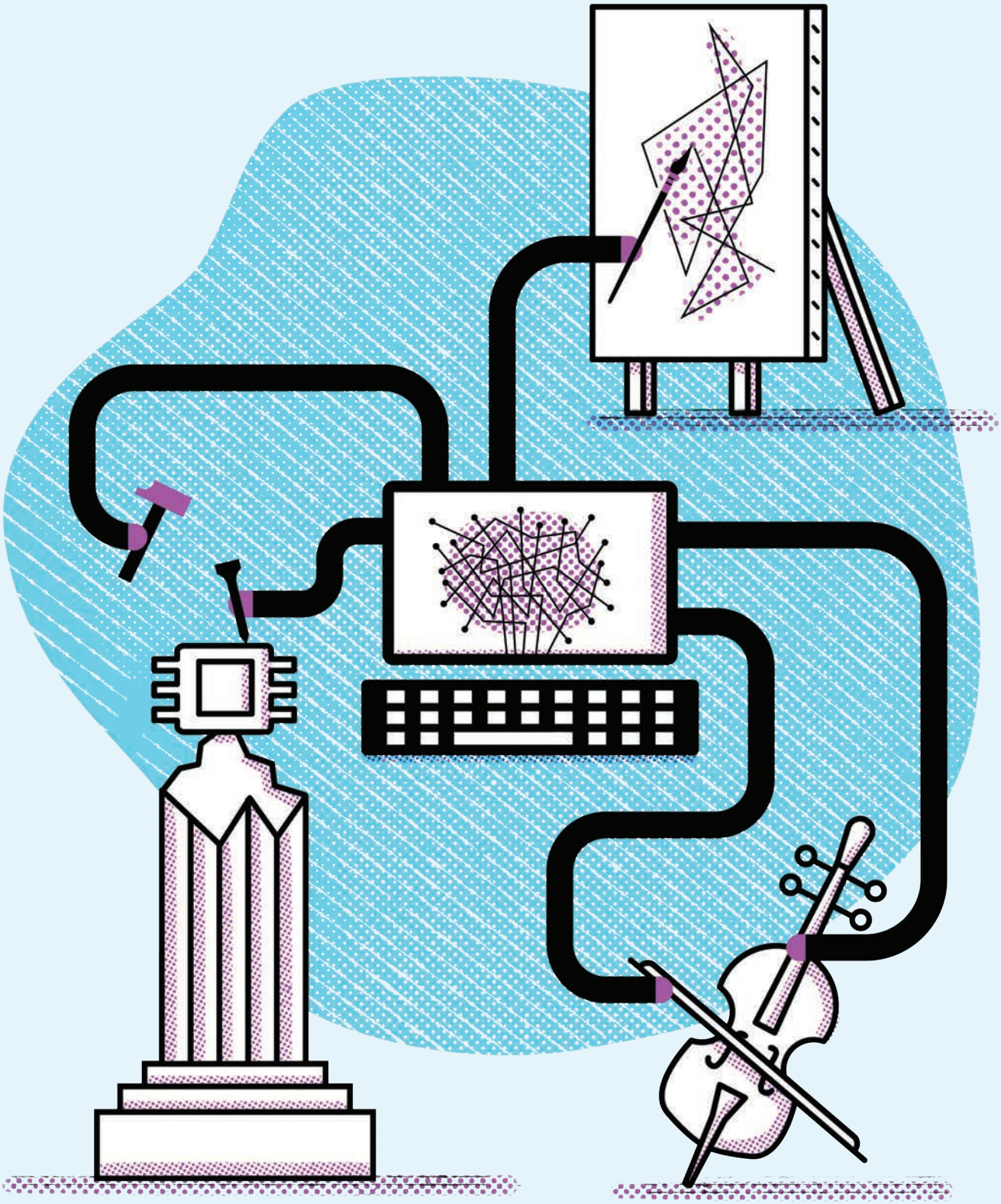
The real revolution isn't happening in internet searches, apps, or media. It's in data. And like when artists started using linear perspective to give the illusion of depth and space to painting, artificial intelligence can be the tool to navigate this new reality.

I have used climate data from Antarctica to algorithmically generate musical patterns. David McCandless founded a blog called Information is Beautiful where he takes data (from movies to humanitarian issues) and plots it into interactive visualizations. He has stated he does this both to produce something aesthetically appealing and to help people understand the world.

In this same vein, data scientists are using algorithms to create art as well. By training on sci-fi films, a neural network that named itself Benjamin wrote a screenplay called "Sunspring." Christie's is auctioning a work of art created by an algorithm that trained on 15,000 portraits painted between the 14th and 20th centuries.

We make new tools and use new ways of thinking to measure the powerful phenomena we experience in everyday life in a data-driven society. Update the tools and metadata and you have the creative economy we have today.

Artists have always used new tools to create new perspectives—in fact, Albert Einstein wrote, "The greatest scientists are artists as well." We can just say this is the beginning of a different kind of conversation.



FROM THE REINS OF CISCO **TO RAISING UNICORNS**

John Chambers, former Cisco CEO-turned-venture capitalist, offers decades of experience and advice to navigate the ever-changing market infrastructure.

BY HOLLY AGUIRRE

JOHN CHAMBERS KNOWS how to spot them. Market transitions, great leaders, technological shifts, and promising companies—the "unicorns" set to become billion-dollar enterprises.

In 20 years as CEO at Cisco, Chambers helped at least 10,000 of his employees become millionaires. He oversaw 180 acquisitions. He grew the company's assets from the millions to the multi-billions. Along the way, he watched others flounder as they tried to navigate economic booms and busts and technological changes. And now, after two decades of creating economic value through one of the world's largest companies, Chambers is dedicated to creating prosperity from the ground up.

"This is a time where you either disrupt or you get disrupted," Chambers boldly states.

Investing over $70 million in 16 innovative startup companies from around the globe, he hopes to change the world one more time with JC2 Ventures by supporting and mentoring the next generation of entrepreneurs.

His focus comes from a belief that almost all job creation in the future will come from startups. "People say JC2 Ventures is a venture capital company. That's fine, but it's much more than that," explains Chambers. "It's a specific, purpose-driven venture capital company. It's about creating the next generation of great companies in this country and around the world."

LESSONS FROM TRANSITIONS

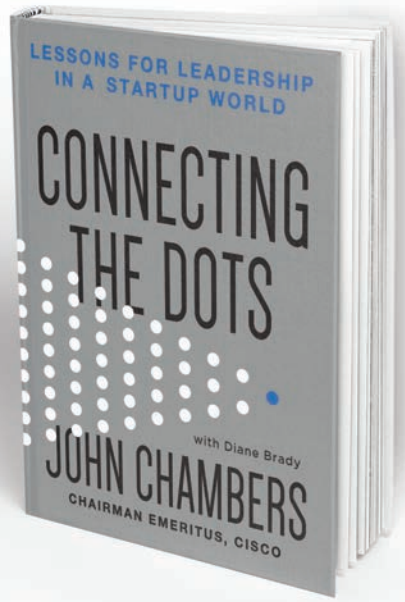
Growing up in West Virginia when it was the chemical center of the world, Chambers saw an industry go from first to worst and the profound effect that could have on a community.

"In West Virginia, people had a very high standard of living," says Chambers. "Then to watch us tumble when the market changed, the implications for the state and for our communities was extremely painful."

At IBM he saw a similar effect when the giant was humbled by the changing PC market.

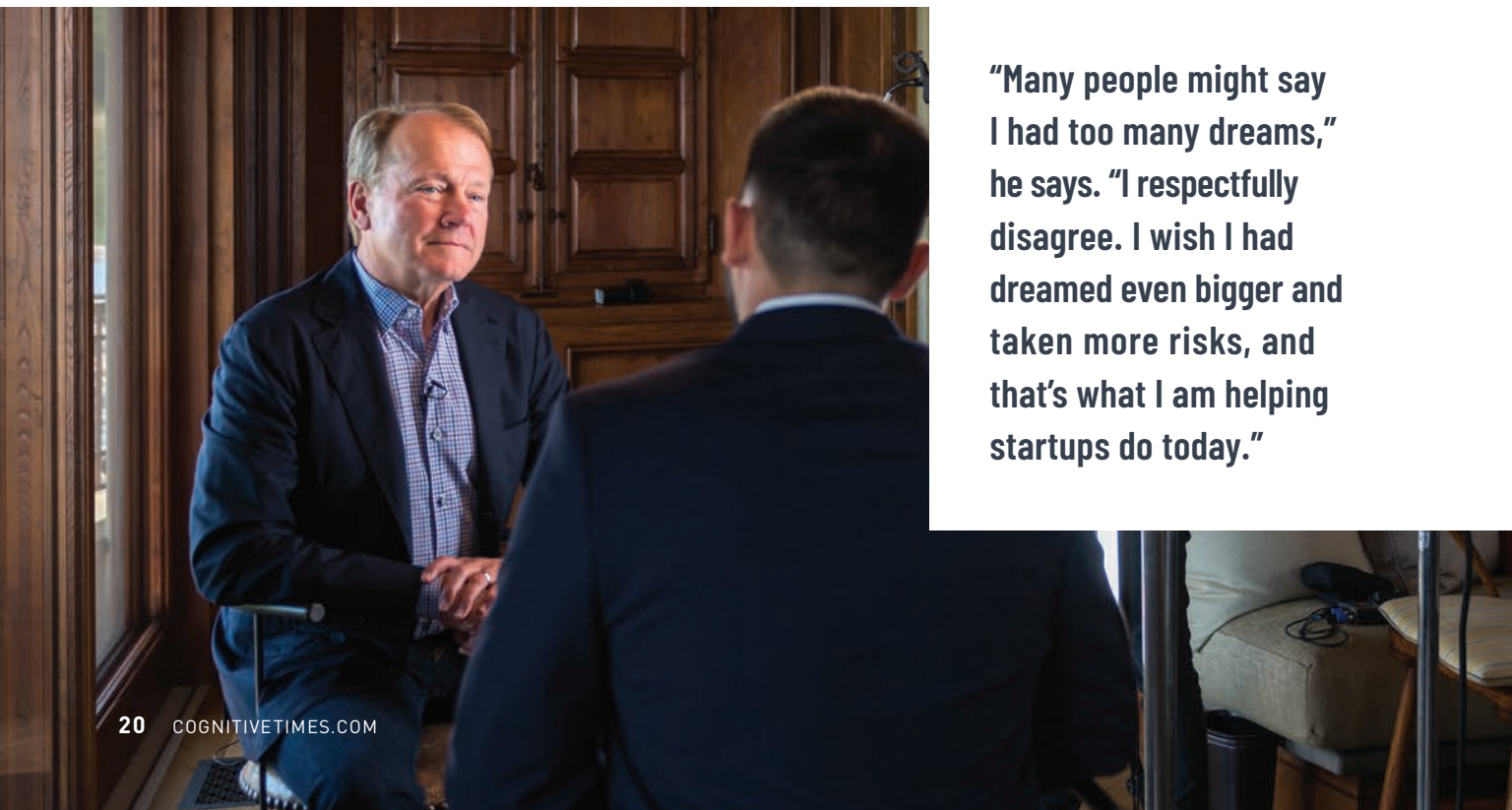
"They missed the transition from mainframes to mini-computers to PCs to the internet. It took them almost 20 years to recover," says Chambers. "That showed me how important it is, once you're on top, to constantly monitor the technology trends and get it right."

Chambers is sharing his business philosophies with the world in his first book, "Connecting the Dots: Leadership Lessons for a Startup World." Providing strategies for leading



companies through market shifts and periods of disruption, he shares the story of how he overcame childhood dyslexia to become one of Silicon Valley's most revered business leaders. He hopes these lessons and mistakes will help the next generation of leaders and entrepreneurs beyond those that he works with at JC2 Ventures.

"I learned to deal with setbacks as a younger person dealing with dyslexia," he says. "You have to deal with your setbacks in life and not panic when they occur. Likewise, if you're going to be aggressive in the market and have a chance to achieve big dreams, you're going to hit some bumps along the way. You want to teach your team that it's how they handle those bumps and setbacks that is so key."



"Many people might say I had too many dreams," he says. "I respectfully disagree. I wish I had dreamed even bigger and taken more risks, and that's what I am helping startups do today."

STARTUPS MAKE US STRONGER

Cisco had some issues that were self-inflicted, while others hinged on the dot-com bubble that burst in 2001. He thinks that perhaps the fear of another "dot bomb" is causing both investors and the government to lose faith in new and cutting-edge technologies. Yet, he maintains that the stock market is too short-sighted and there are simply not enough startups and unicorns in the U.S.

"We used to be the number one leader on innovation in the world; right now, we're number 11," says Chambers. "We used to lead the world in terms of startups, but the number of new companies starting in the U.S. is at a 40-year low."

"With artificial intelligence and the business process changes that are occurring, the majority of large companies will not add headcount over the next decade," he continues. "So if we're going to employ more people here in the U.S. or in Europe or in Asia, we have to look at how to get these startups growing faster and being more focused."

In terms of startups per capita, the United States is currently lagging behind Israel and the UK, to name a few. According to Chambers, a robust startup landscape is required for economic growth and innovation, two cornerstones of any country's leadership position on the world stage that are also vital to a thriving society.

Chambers asserts that our government needs to promote more technological innovation and that we all bear some responsibility in a societal contract to foster a good startup culture. "I think you've got to be very transparent both with the market, with your customers, with the citizens and society about the challenges we face as well as the opportunities, and then say how do we address those challenges," says Chambers. "I think now is a time when business and governments and citizens must work together. Business cannot hide behind the scenes by saying, 'but that's society's problem.'"

THE CHAMBERS EFFECT

While he doesn't have a crystal ball, Chambers has an unprecedented knack for spotting major transitions and picking the right pony. With his investments, he looks for companies with new business models, groundbreaking technology, a world-class CEO, and a focus on customers.

Chambers likes to personally nurture all of his projects and considers himself to be in partnership with every CEO, including his work with Aspire Food Group (which has a mission of solving world hunger through crickets) as well as artificial intelligence company SparkCognition.

"When I started investments in key companies, my investments were as much mentoring and coaching as they were financial. My goal is to be a true partner with the CEO on his or her journey," says Chambers. "With each of my startups, and especially at SparkCognition, I look for potential market growth and an impending transition."

THE MARKET TRANSITION

The next big thing, according to Chambers, is automation (to wit, Aspire is a robotic farm) and artificial intelligence. He believes that even though AI may seem over-hyped, it is going to be the greatest productivity factor in our lifetime.

"It will have challenges in terms of changing business models and how we create jobs for those employees who get displaced.

Intelligent devices and intelligent processes will be everywhere in the network, from the cloud to data centers throughout the network all the way to the edges," he says. "The key will then be the security of all of the above, because the true currency of the future will be trust and a strong track record, and security is at the heart of that."

Chambers believes artificial intelligence will allow people to live longer, be dramatically healthier, and have a higher standard of living—if we do it right. He predicts the pace of digitization, AI, and automation taking hold in everyday life will be "three to five times faster" than the transitions the internet brought.

"AI and automation will transform everything we do in terms of digitization in our lives, our businesses, our cars, and our homes. That said, as with any major change, there will of course be challenges. We've got to be realistic on how we're going to manage those challenges and the legitimate concerns of citizens and government," he cautions. "Change makes people uncomfortable, no matter how much you believe it's needed. This is something that's going to happen, period. So, how we get ahead of it, and how we balance it, is the key takeaway."

WHAT MAKES A WORLD-CLASS CEO

Partnering with a company like SparkCognition is exciting for Chambers, not merely because of the technology, but because of the people involved as well. Chambers always looks for leaders who are focused on market transitions and not on competitors. These CEOs can sense when their company is near an inflection point and know how to take advantage of that and drive it forward. Digitization presents such an opportunity.

"Digitization is clearly at the very forefront of how you use artificial intelligence to change business process and business models," he says. "But it's not about technology. It's about the outcome you want, and it's how a leadership team can work together to be truly brilliant. I think one of the top young CEOs in the world, Amir Husain, has a vision of what he can do and how he uses these market transitions to achieve these outcomes."

Chambers says that what is so "wicked smart" about Husain is that he knows what he doesn't know, and is willing to ask for advice. And it definitely takes a great leader to know one—Chambers has racked up countless accolades for leadership style and his success as a CEO, including being named one of Time's 100 Most Influential People and Harvard Business Review's 100 Best-Performing CEOs in the World.

A key lesson for CEOs is to "deal with the world the way it is, not the way you wish it was," says Chambers. "Setbacks are inevitable. If you're taking good business risks, determine how much the setbacks were self-inflicted and how much of it was the market. If the majority of it was market, you need to focus on how to come out of it. If your strategy was working before, stay with it. If the issues were created internally, then you've got to fix the issues." He stresses, "How the CEO navigates through difficult situations determines the success or failure of the company."

LISTENING TO CUSTOMERS

For Chambers, the conversation will always come back to company culture ("ultimately, creating culture is one of the cornerstones of good business," he says). Chambers made Cisco a family, and was rewarded with some of the lowest turnover in the industry and employees who worked to help the company bounce back when necessary. He makes it a point to treat employees and customers alike with respect, and in fact, Chambers credits customers with his ability to sense market transitions.

"You're often more a product of your past in terms of how you're able to see the future and how you learn from it," he says. "So, what I do when I think about market transitions is listen to my customers."

With these elements in place—a culture-oriented company, a world-class team empowered to have a huge impact, and an impending market transition—Chambers advises setting "audacious" goals. "Many people might say I had too many dreams," he says. "I respectfully disagree. I wish I had dreamed even bigger and taken more risks, and that's what I am helping startups do today."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AUTONOMY IN THE SKY

by **Alex Amari**

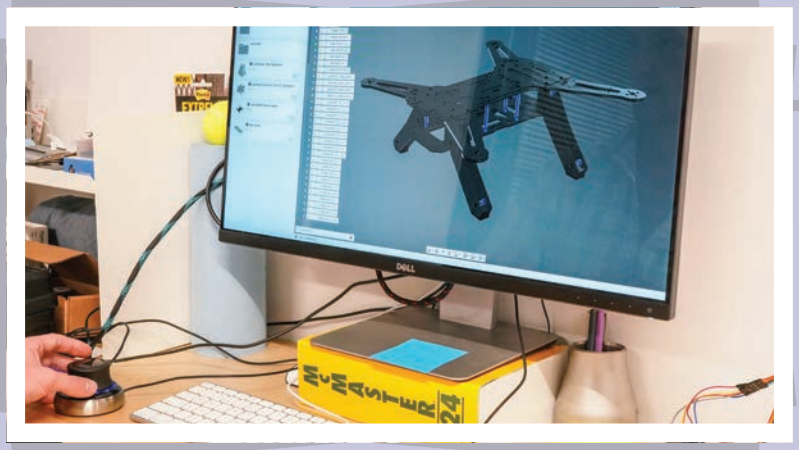
You're walking around your neighborhood park when you hear a low buzzing from above you. You look up to see a drone flitting around the sky. You make a logical assumption: There must be someone nearby piloting it. When you quickly scan your surroundings, you can't find a remote pilot. Could this drone truly be flying itself?

> SPARKCOGNITION'S EXPERIMENTAL UNIT, SPARKLABS, HAS BEEN APPLYING ADVANCES IN AI AND MACHINE LEARNING TO RESEARCH AND DEVELOP AUTONOMOUS DRONES.

Most people are familiar with unmanned aerial vehicles (UAVs), more commonly known as drones, for tasks like taking aerial pictures or delivering mail. However, these days UAVs are also used to save lives. When Hurricane Harvey devastated Houston and rising water shut down streets and highways, drones played an essential part in surveying flooded areas to assess damage and determine if levees would hold. They also identify people in need of help, and when ground-based rescue is too dangerous, drones can deliver supplies like life jackets and ropes.

Despite this life-saving capacity, UAVs remain rare in such public service uses. In addition to budget concerns, most drones require a skilled human controller to pilot them per FAA regulations, and first response teams lack trained staff. If drones are to become practical in areas like search and rescue or disaster response, they need to be highly autonomous. In other words, they'll need to fly themselves.

SparkCognition's experimental unit, SparkLabs, has been applying advances in AI and machine learning to research and develop autonomous drones. The team shared their progress of designing, building, and testing an autonomous UAV. Ultimately, SparkLabs hopes to build an autonomous drone fleet capable of aiding first responders during the most challenging missions.

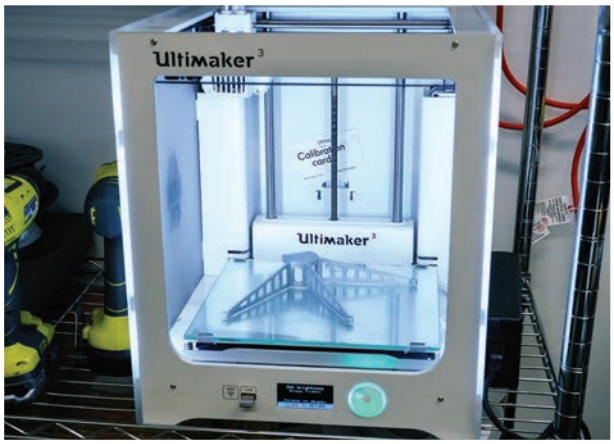


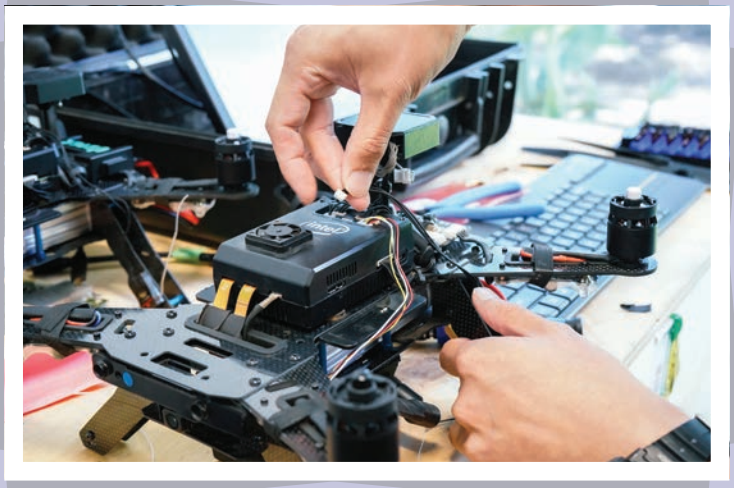
1 CAD

THE FIRST STEP OF ANY UAV BUILDING PROCESS IS CAD, which stands for computer-aided design. CAD helps the engineers identify the proper components for the drone and optimize them to ensure flight readiness. Here, the team is customizing the carbon fiber body of the UAV so it can hold all of the necessary electronics to fly autonomously.

2 BUILDING COMPONENTS

WITH THE DESIGN FINALIZED, THE TEAM COMPILES THE NECESSARY COMPONENTS. While most of the electronics—the sensors, cameras, and processors, for example—are purchased pre-built, other components must be created in the lab. The team uses a 3D printer to make customized brackets and casings to hold onboard devices and wires. A key challenge in this process is making parts that are compact and light enough for the drone to remain aerodynamic, but also strong enough to hold and protect delicate electronics.





3 ASSEMBLING THE DRONE

WITH THE COMPONENTS ASSEMBLED, IT'S TIME TO BUILD THE UAV. First, key parts are fastened around the drone's body in the custom-built casings, including its battery, propellers, sensors, antennas, and processors. Then, an intricate network of wires is installed, linking the components together for data and power connections. Assembly is a delicate and painstaking process, much of which must be done by hand.

4 WRITING THE SOFTWARE

AFTER THE DRONE IS ASSEMBLED, IT MUST BE PROGRAMMED TO FLY PROPERLY. Sensor data from onboard accelerometers, tilt sensors, distance sensors, and other devices are fed into algorithms that help control the drone's motion during flight. Next, machine learning algorithms are added to help the drone "learn" how to fly itself to accomplish its mission. In addition to ease of use for first responders, autonomous drones have the potential to be more precise thanks to input from the sensors.

5 PREPARING FOR FLIGHT

IN PREPARATION FOR THE TEST FLIGHT, the team conducts quality assurance trials to ensure all the UAV's electronics are functional. The drone will be using real-time image data coming from four cameras on its body to navigate itself towards a landing pad. If all goes to plan, the drone will take off from a random location nearby, search for the landing pad, and land itself safely and accurately in its center.

6 TEST FLIGHT

LIFTOFF! For a moment, the UAV seems unsteady, as though it were trying to find its balance. In a matter of seconds, though, the drone's internal algorithms take control, using the data coming into the drone's sensors to determine the right rotor speed and angle to achieve stability.

The drone begins a slow spin about its vertical axis, its cameras collecting hundreds of image frames per second in search of its target. It comes to a stop, facing the direction of the blue box.

Slowly but surely, the UAV drifts towards to the center of the pad. Once directly above the center, it begins its vertical descent.

Right on target!

AS THESE TECHNOLOGIES DEVELOP, THEY HAVE THE POTENTIAL TO TURN AI INTO A BEACON OF HOPE FOR THOSE IN NEED.

While landing on a small blue target may seem like a small achievement at first glance, it speaks volumes about the future of autonomous drones. Imagine the small blue target is a person trapped on a rooftop after a hurricane that human responders can't locate or reach.

Engineering challenges remain, such as weather-proofing drones so they can fly in rain, heavy wind, and other harsh conditions of emergency situations while avoiding obstacles like trees or power lines. As these technologies develop, they have the potential to turn AI into a beacon of hope for those in need.

PRODUCT MANAGEMENT 2.0

LESSONS FROM GOOGLE IN BUILDING AI PRODUCTS IN THE SOFTWARE 2.0 WORLD

In the new world of software, if-then statements are out the door, there's often no UI, and failing is inevitable. What is a product manager to do?

by **Erin Russell**

IN NOVEMBER 2017, the Director of Artificial Intelligence at Tesla wrote a post on Medium stating that neural networks "represent the beginning of a fundamental shift in how we write software." Rather than coding rules line by line for each module, neural networks are trained on labeled data which they use to discern their own rules, often finding previously unknown patterns. This change in software necessitates a new strategy for product management. As an early adopter of this pivotal technology, Google is the premier company to learn from in this area.

BUILDING INTERNALLY, SHARING GLOBALLY

Google has been using machine learning to improve products throughout its history. When Apoorv Saxena, a former McKinsey consultant and entrepreneur, joined Google in 2012, the company was already making use of deep learning, access to high computational power, vast datasets, and cloud-based storage. With these tools, it was achieving breakthrough results in domains like image understanding, speech recognition, and text translation.

"We started seeing some amazing improvement in our ability to make predictions on unstructured data and language understanding," explains Saxena, Head of Product Management for AI Verticals. "And a lot of those dramatic changes and improvements were coming out of Google's own research."

One key decision Google made when incorporating machine learning, according to Saxena, was to not only publish the results of this research publicly, but to build internal machine learning tools that enable Google employees to build products. "This accelerated the process of applying machine learning to our core applications," he explains. "I'll give you a very personal example from when I was a product manager on the G Suite team. Every year, Google does a hack-a-thon. I thought, I'll put together a team to create a bot. This was 2014, when bots were still early. We set out to create a simple bot that understands a Google Hangouts thread and can answer questions.

"The beauty was that we were able to do this in a 48-hour hack-a-thon using the tools that Google had internally built. If I'd been outside the company, the same task would have taken me at least six months, with worse quality. My hack-a-thon team won second prize and that was for me, personally, an aha moment—that such a powerful tool could be created so simply and easily."

Saxena wasn't the only one who saw the technology as a breakthrough—Google quickly set out to train tens of thousands of employees on the potential of machine learning. This training was also made publicly available, and the company built an open source deep learning framework, TensorFlow, to help democratize the adoption of AI.

THE SOFTWARE 2.0 DIFFERENCE

As more companies incorporate AI algorithms, there is an increasing realization that building AI software (also called Software 2.0) differs significantly from traditional coding.

Creating traditional software relies upon establishing "if-then" rules. While this is doable, if cumbersome for certain applications—say, "if an email contains 'Nigerian price,' it is spam"—it is nearly impossible to hardwire all the rules necessary for complex situations—say, self-driving cars or a Google Assistant that answers your questions.

"THE BEAUTY WAS THAT WE WERE ABLE TO DO THIS IN A 48-HOUR HACK-A-THON USING THE TOOLS THAT GOOGLE HAD INTERNALLY BUILT. IF I'D BEEN OUTSIDE THE COMPANY, THE SAME TASK WOULD HAVE TAKEN ME AT LEAST SIX MONTHS, WITH WORSE QUALITY. MY HACK-A-THON TEAM WON SECOND PRIZE AND THAT WAS FOR ME, PERSONALLY, AN AHA MOMENT—THAT SUCH A POWERFUL TOOL COULD BE CREATED SO SIMPLY AND EASILY.

Apoorv Saxena
Head of Product Management for AI Verticals
Google

Such complex products are now written using deep learning techniques that require a training data set (say, examples of spam and normal emails) to analyze patterns and establish rules. While this code is much simpler to write compared to traditional software, Saxena points out that there are no standardized tools and frameworks available to build Software 2.0 products—at least, not yet.

"The Software 2.0 stack is just emerging," he says. "In our view, its evolution is going to be very similar to how mobile and web stacks standardized over time. Our hope is that TensorFlow is going to be one of the frameworks that gets standardized, but there are still many missing pieces. For example, there is no standardized way to manage data scientists workflows for gathering, cleaning, and labeling training datasets. A set of tools needs to be created to truly drive widespread adoption of AI."

REINVENTING PRODUCT MANAGEMENT

Just as building Software 2.0 products requires new development tools and practices, product managers overseeing these solutions need to reinvent their craft. Traditionally, product management starts with defining customer journeys. "You're focused on how customers use your product," explains Saxena. "How they are going to send or read or sort." This means that the build-out to add new features is constant.

While the customer-centric approach is still relevant in product management 2.0, there's a completely new set of skills, processes, and tools to apply. "For example, Google Assistant is a 2.0 product. But there's no user interface in the traditional sense, such as the one you have in a mobile app with a touch screen," says Saxena. "You as a product manager need to redefine your customer user journey for a conversational interface such as the one in Google Assistant. In this case, there is no set user journey that you optimize through UI artifacts to guide user behavior. Conversations are much more free-flowing and you need to modify your approach accordingly.

"You also need to redefine the concept of minimal viable product or features," he continues. "To build a new feature in Google Assistant such as answering 'How is the weather today,' you need to start thinking about the minimal viable dataset you need to bootstrap your feature. In this case, it will be dataset of user utterances that all correspond to the user intent to find information about the local weather."

The other big difference between traditional and new product management, according to Saxena, is designing the user experience to be fault-tolerant: "In software 1.0, when I write a code, I'm a hundred percent sure that if you ask me to send email, the code will always send email. In a Software 2.0 world, it's essentially a model predicting with very high probability what are you asking it to do. So, if you ask a model trained to understand images of animals whether an image is of a dog or cat, the model is never a hundred percent sure it is either."

The question for product managers becomes, how do you handle failure when the AI model gets its prediction incorrect? One way is to have the model return a percentage of certainty. Another is to suggest alternate responses, or still another way is to provide reasons for the model prediction—Saxena calls this "graceful failing."

Finally, PMs must be aware that training datasets can hold hidden biases. For example, an algorithm to identify CEO candidates may deliver more men than women. Saxena asserts, "As a product manager, if you don't have an understanding of the biases that can exist in your training data and your model, you will design an inferior product. It is the job of the product manager to ensure that the model's predictions are fair. This is something most traditional PMs never had to worry about." Google is proactively providing tools for product managers to better understand such biases. In the recent release of the Google Contact Center AI and AutoML products, Google released a set of AI principles and guidelines for product managers to follow to ensure model fairness.

All the above also implies that the profile of a product manager hire changes a bit, too. In fact, when hiring PMs, Saxena looks for high levels of empathy. "AI is powerful tool. With great power comes great responsibility, and we have to be very careful about the technology we are building," he explains. "We need people who can take the long view and understand that there are some very valid ethical dilemmas in how the power of AI is used."

STRATEGIC PARTNERSHIPS

As much as the Google team accomplishes, it is not done in a vacuum. Saxena notes that "a whole new AI ecosystem is evolving," as the company partners with companies like Nvidia and Intel to build specialized hardware, Kubernetes to optimize computing infrastructure, and Figure Eight to create data labels.

"We want to democratize access to AI," Saxena explains, "This means contributing to the open source movement and working with partners to enable capabilities across the whole stack."

"AI is a very generic set of tools," he continues. "The big value we believe our partners can provide is taking the tools we are building and customizing them to a particular use case, or a particular vertical.

"AI is going to be transformative across every industry," he concludes. "Almost every week, I get pleasantly surprised by the novel ways people are using the tools we have built."

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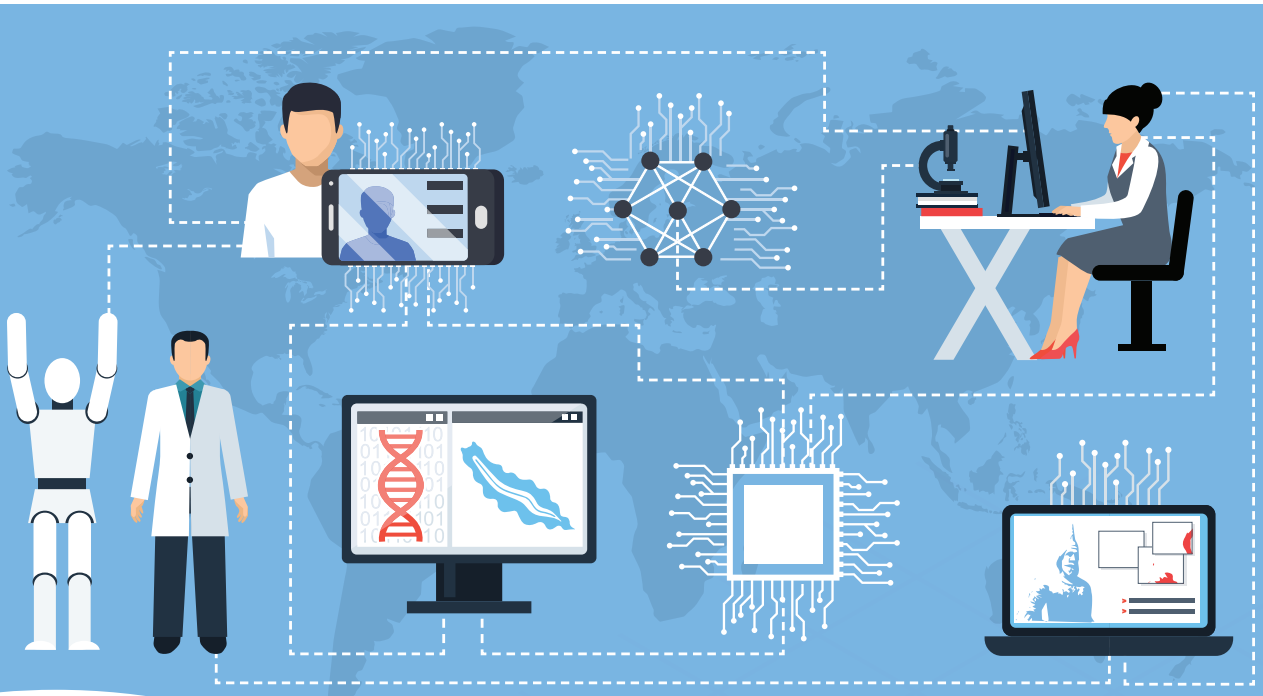
5 UNDER-THE-RADAR FEATS OF ARTIFICIAL INTELLIGENCE

by **Erin Russell**

Artificial intelligence has applications in a wide range of industries, but often the focus is on famous wins like AlphaGo or an exciting potential use still many years in the future. This leads many to say that AI is not delivering on its promises to revolutionize the human experience. We don't yet have artificial general intelligence (AGI) that is broadly applicable to all aspects of everyday life, but instead have narrow AI specific to a task. So what is this narrow AI capable of right now? Well, a lot, it turns out. We chose five of the most exciting accomplishments that have received little press, but are benefitting society today.



1 MAKING SCIENTIFIC DISCOVERIES

AI at Tufts University independently solved a 120-year mystery surrounding flatworms. Genes from a sliced flatworm will regenerate into a new organism, but scientists were stumped as to how the genes knew what shape and proportions to grow in.

A team of biologists and computer scientists worked together to program an AI system with data from studies concerning this phenomenon. The system created random simulations of the network formed by the worm's genes until it matched the results of an experiment from the data set. It would use this information to hone the simulations until it created a core genetic network that worked with all the known studies.

While this trial-and-error method would be prohibitively inefficient for humans, within three days the system deduced that the process involved three known molecules and two unknown proteins. This work is being used for research in areas like transplant surgery and regenerative medicine.

2 RESTORING LOST ARTIFACTS

While art and monuments may be treated with reverence by most, it only takes one disaster to destroy them forever. There are several projects underway to capture these important pieces of history digitally, or even recreate them from images.

Project Mosul, which was spurred by videos of terrorists smashing artifacts at Iraq's Mosul Museum, uses 3D modeling software to recreate lost works from photographs. Iconem, a Paris-based company of "heritage activists," uses AI to stitch together thousands of photos taken by drones into a 3D model.

This digital preservation helps not only aid workers trying to assess the damages, but also teachers trying to impart knowledge about civilizations.

3 PREVENTING ONLINE HARASSMENT

The comments section of a website has the potential to add thoughtful perspective to a publication or devolve into frightening cases of harassment. Many websites disabled comments as monitoring them simply got too logistically (and emotionally) difficult. However, machine learning tools like Perspective, developed by Google and Jigsaw, look for patterns of abuse in specific users and score comments based on perceived impact on a conversation. Before using Perspective, the New York Times only enabled comments on 10% of its articles; today, they have been able to triple that number and include all articles on the homepage, while keeping discussion productive.

4 DETECTING CROP DISEASE AND YIELD

Recent developments with AI and agriculture are working to help feed our planet. A team of researchers at Pennsylvania State University and the École Polytechnique Fédérale of Lausanne, Switzerland have built an image recognition program for plant disease, which operates with 99.35% accuracy. The program can even be operated via smartphone, which is particularly useful for smaller-scale farming operations.

In addition, much work is being done with AI systems to predict crop yield, using input like historical yield, sensor data, or image recognition. Farmers use this information to optimally position crops for maximum production, ensuring their hard work will feed the most people possible.

5 BEATING HUMANS AT IQ TESTS

The AI system Watson was the champion of Jeopardy! in 2011, but modern AI systems have also mastered the IQ test. Researchers from Microsoft and the University of Science and Technology of China built a deep learning system to take IQ tests, which comprise questions in math, logic (patterns in a series of images), and verbal reasoning (classification, synonyms, and everyone's favorite, analogies). When tested against a group of 200 volunteers, the system outperformed the average human, earning a score between those with a bachelor's degree and a master's degree.

Training algorithms to reason for IQ tests represents a step toward AGI. While we still have yet to surmount the challenge of true general intelligence, we are certainly creating more capable robot assistants.

THE ETHICAL ALGORITHM

AI's calculating algorithms are often touted as the unbiased, exact answer, but recent cases of people failed by an automated system question this notion. How can we keep AI ethical?

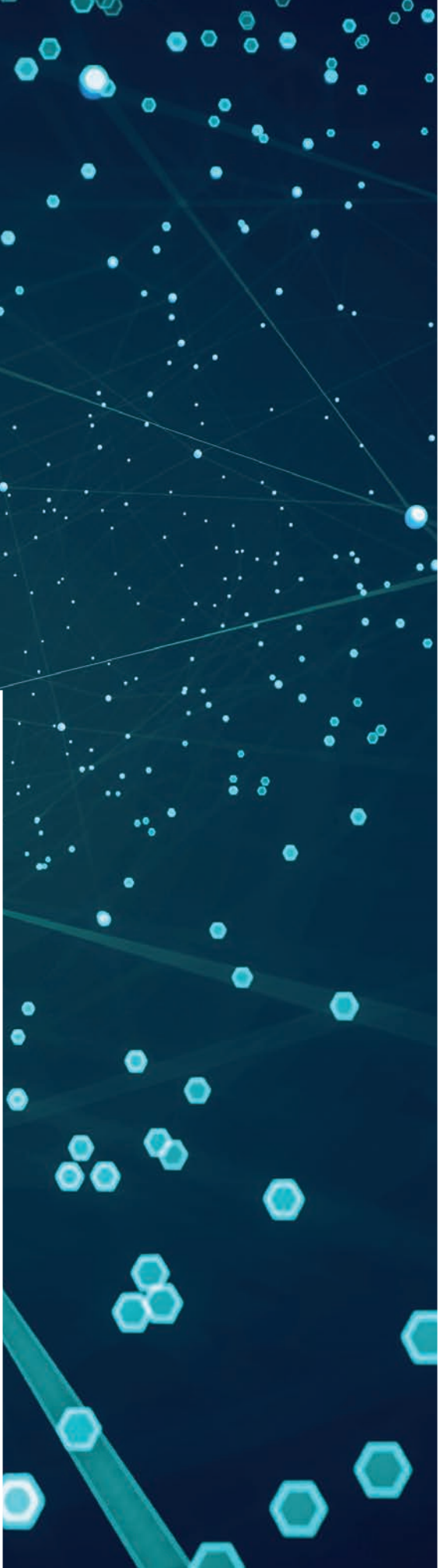
by **Erin Russell**

Artificial intelligence (AI) is often touted as the enlightened path to decision-making free of human bias. Whereas we humans are subject to favoritism, nostalgia, racism, and other problems that cloud our judgement, AI algorithms are trusted to deliver the cold, hard truth. For this reason, the state of Arkansas entrusted allotment of Medicaid home services to an algorithm in 2016, citing that the human system fell victim to arbitrary decisions.

However, the new algorithm resulted in hundreds of people having their home services reduced. Some were hospitalized as a result.

Even worse, there was no way to challenge the system, as the state simply pointed to the algorithm as a single source of truth. After repeatedly being denied an explanation for her reduced services, a woman named Ethel Jacobs sued the state. Mid-trial, the state's lawyers were forced to sheepishly report that there had been a calculation error and her services would be restored.

This is the problem with proclaiming AI to be universally "unbiased." Generally, it's humans who create the datasets and write the algorithms. Thus, it's entirely possible that human bias or error can be encoded in a machine learning (ML) algorithm, despite being set forth as a neutral method of providing an answer. This can have far-reaching consequences.



WE FOUND THAT APPLYING AN ML MODEL TO INFORM POLICE DEPLOYMENT DECISIONS COULD EXACERBATE EXISTING UNFAIR RACE-BASED DISPARITIES IN THE ENFORCEMENT OF DRUG LAWS.”

Kristian Lum, PhD
Lead Statistician
Human Rights Data Analysis Group

IS DATA ALWAYS FAIR?

“When we’re talking about using AI to make predictions that involve individuals’ liberty, this is a natural place for questions of ethics and fairness to arise,” explains Kristian Lum, PhD. Lum is the lead statistician at the Human Rights Data Analysis Group, which applies science to human rights violations around the world. She joined the group while doing research on the uses of machine learning and predictive modeling in the criminal justice system in the United States.

Lum feels that until recently, many people assumed that better models and more technology would decrease the amount of bias in AI. However, she notes that ML-based models can reproduce the exact human biases they are meant to overcome. For example, she says, “In my work on predictive policing, we found that applying an ML model to inform police deployment decisions could exacerbate existing unfair race-based disparities in the enforcement of drug laws.”

In Lum’s example of predictive policing models, it would be difficult to obtain a truly representative, complete dataset based simply on police reports. Certain crimes are over- or underreported, certain neighborhoods are policed more than others, and police are more likely to investigate certain types of criminals. Thus, the dataset is not representative of crime rates, but rather of how police respond to and record criminal incidents. Given that these biases then create a biased legal system, it seems algorithms have a herculean task to overcome.

Lum adds, “It’s important that designers of AI-based systems, whether inadvertently or intentionally, don’t cause more harm than good. The devil’s in the details, of course, and quantifying both ‘harm’ and ‘good’ is not straightforward. It involves careful thought about who in particular might be harmed and who is benefitting from the technology.”

ETHICS 101 FOR AI

To that end, Nell Watson, a member of the artificial intelligence faculty at Silicon Valley think tank Singularity University, co-founded EthicsNet, which seeks to create a dataset for machine ethics algorithms. Taking a page from ImageNet, a massive repository of labelled images, Watson seeks to collect data sets for machines to learn from so they behave in a more sociable, friendly, and kind manner.

Watson takes the interesting stance that humans are "a biological AI system that happens to be implemented in a primate." She argues that what makes us human is our cultural data set, and as we delegate more of our decisions to algorithms, giving machines this "software" will help them fit into society.

Watson explains that the aim of EthicsNet is to replicate "a well-raised six-year-old child" in terms of moral reasoning capabilities. "We're not trying to solve the great philosophical issues," she says. "We're just trying to generate a system that recognizes that if you see some trash lying around in the street, it would be a nice thing to pick that up and put that in the bin.

"If we are delegating a lot more of our decisions to our machines—economic decisions but also social decisions—they reflect on us," she continues. "Machines need to be taught how to be socialized, how to act in a way that is likely to fit nicely in with society, and not cause alarm or consternation among other people."

THE BLACK BOX PROBLEM

Another concern with AI is the need for explainability of a model that also includes trade secrets—in other words, how to audit a model without completely giving away how it works or the private data that goes into it. "You're inviting people to give away their proprietary secret sauce," Watson explains. "And I think a lot of companies would be very, very loathe to do that for quite understandable reasons."

Lum adds that there has recently been interesting work surrounding the auditing of black-box models. Rather than revealing all the details of the system, a company could provide an API (application programming interface) so that auditors could test inputs and see the corresponding outputs of the model.

Watson also sees cryptography as a way to secure private data: "I believe that the confluence of blockchain and AI is going to be essential. I think that the 2020s are going to be concerned with this junction between machine intelligence, machine ethics (loading values into machines and giving them a bit of moral wisdom), and machine economics (blockchain and similar kinds of crypto-tech-technologies)."

A MORE ETHICAL FUTURE

This is not to say that AI is always biased or unethical. In July, the Harvard Business Review published an article entitled "Want Less-Biased Decisions? Use Algorithms," which cites five examples of algorithms producing less biased conclusions than human counterparts despite training on data with historical prejudices (for example, an algorithm that determines if children should be placed in protective services).

However, Rachel Thomas, PhD at fast.ai, points out that the Harvard article ignores several major discussions. For example, algorithms are often implemented without an appeals process, as seen in the case of Arkansas healthcare, and encounter little supervision. Algorithms are also often employed at a much larger scale than human decision-makers because doing so is more cost-effective. Thus, an algorithmic mistake causes more widespread damage than a few humans making biased decisions.

Moreover, she argues, "Instead of just focusing on the least-terrible existing option, it is more valuable to ask how we can create better, less biased decision-making tools by leveraging the strengths of humans and machines working together." In fact, when Google released their guidelines for responsible AI practices this year, the first recommendation was to put humans at the center of the design process.

"What we are trying to solve is not solely a technical problem," Lum elaborates. "There's increasing recognition that developers need to engage with social scientists, policymakers, and ethicists when designing systems that will inevitably impact lots of people."

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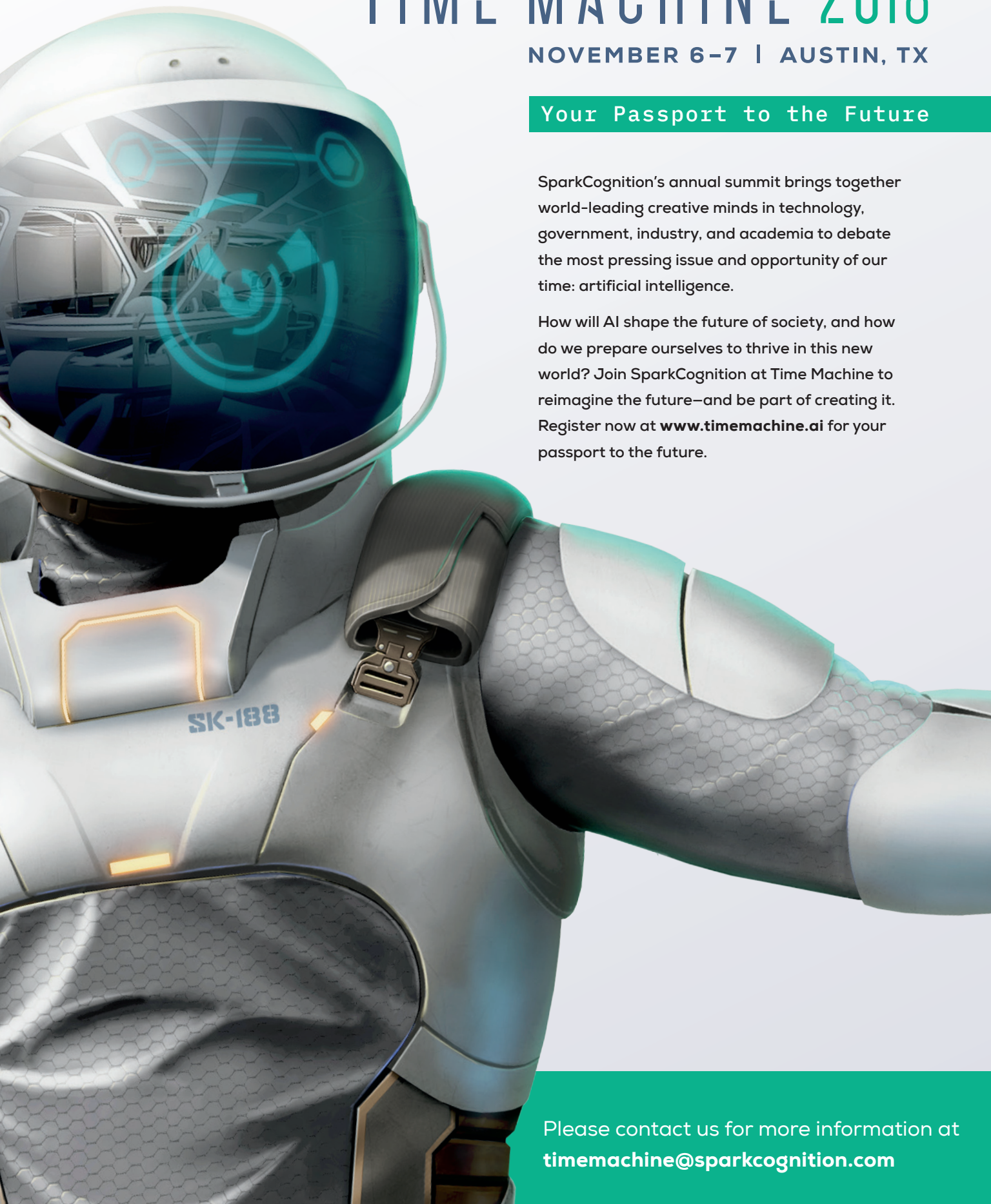

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THE DIGITAL BATTLEFIELD

AI'S ROLE IN CYBERSECURITY

Emerging technologies create a new warfare where hackers destabilize entire regions and governments. AI is becoming the force for good in combating this.

by **Lily Karlin**

Cybersecurity once meant protecting against small-scale hackers trying to get a quick payday. However, recent hacks have halted airport operations, exposed classified government documents, and even affected the democratic process. In 2016 and 2017, an entire region of the Ukraine—homes, schools, and hospitals—was dangerously left without power in the dead of winter due to persistent cyber attacks on the region's utility companies. Cyber innovation isn't just about protecting individuals—it has assumed a vital role in securing critical infrastructure.

Mike Hamilton, the newly appointed CEO of cybersecurity company Ziften, sees AI as pivotal to the development of systems equipped to meet the complex threats of a new cyber landscape.

"It is … literally armies of nation-states trying to get intellectual property, trying to affect public opinion," Hamilton explains. "It's really taken the cybersecurity space to a completely new plane."

WARFARE BY OTHER MEANS

Recent political events have demonstrated the capacity for both state and non-state actors to destabilize centuries-old political establishments. Well-executed attacks have the power to influence international politics and inflict complete operational shutdown of targets. Russian state-sponsored cyber activity allegedly influenced the 2016 American presidential election. Concentrated hacking efforts to access information, halt operational functioning, or, in some instances, both, have also targeted U.S. universities, hospitals, airports, and conglomerates like Sony and Disney. Next to today's highly organized, often state-sponsored cyber-missions, once-worrisome email scams are child's play. Newly complex attacks have fittingly led to major transitions in the cybersecurity industry, particularly for companies that focus on endpoint security, like Ziften.

Endpoint security fights cyber attacks by protecting infiltration-prone devices such as desktops, laptops, smartphones, tablets, servers, and cloud infrastructures. The field has historically been split into two sectors: endpoint protection and endpoint detection and response.

Endpoint protection, which includes technologies like anti-virus and anti-malware software, serves as a first line of preventative defense against attacks. It primarily functions by looking out for known or familiar attack signatures.

Endpoint detection and response monitors and analyzes data and network events on an ongoing basis to spot potential suspicious activity and real-time breaches. It also includes post-attack forensic analysis and response development.

Despite the historical separation of protection and detection, the division between the two is swiftly evaporating. With the complexity of contemporary attacks, companies increasingly require the entire array of tools combined into one comprehensive, high-functioning system. Ziften illustrates how security-conscious companies are stepping up to fill this need.

"Working with 30 different tools is just so difficult, given all the different alerts that are popping up. They're trying to hunt down alerts and figure out what's going on," Hamilton said. "Something that we're heavily focused on is simplifying the endpoint. It's bringing a single agent to deliver both the advanced (anti-virus) protection as well as post-breach forensic components."

THE AI ELEMENT

For Hamilton, artificial intelligence takes center stage as this simplifying agent.

"Machines are typically black and white," Hamilton said. "Humans have a little bit of gray when it comes to cognitive ability. Using technology to bridge black-and-white machines into that gray area is a fascinating development."

So what exactly does that gray-area operation look like? Equipped with machine learning technology, a security system can actually improve its own code. Engineers, who would otherwise have to program software to be on alert for known threat signatures, can instead expose it to millions of cyber threats as a learning process. The software discerns their underlying makeup and identifying details, increasing its ability to protect against never-before-seen threats.

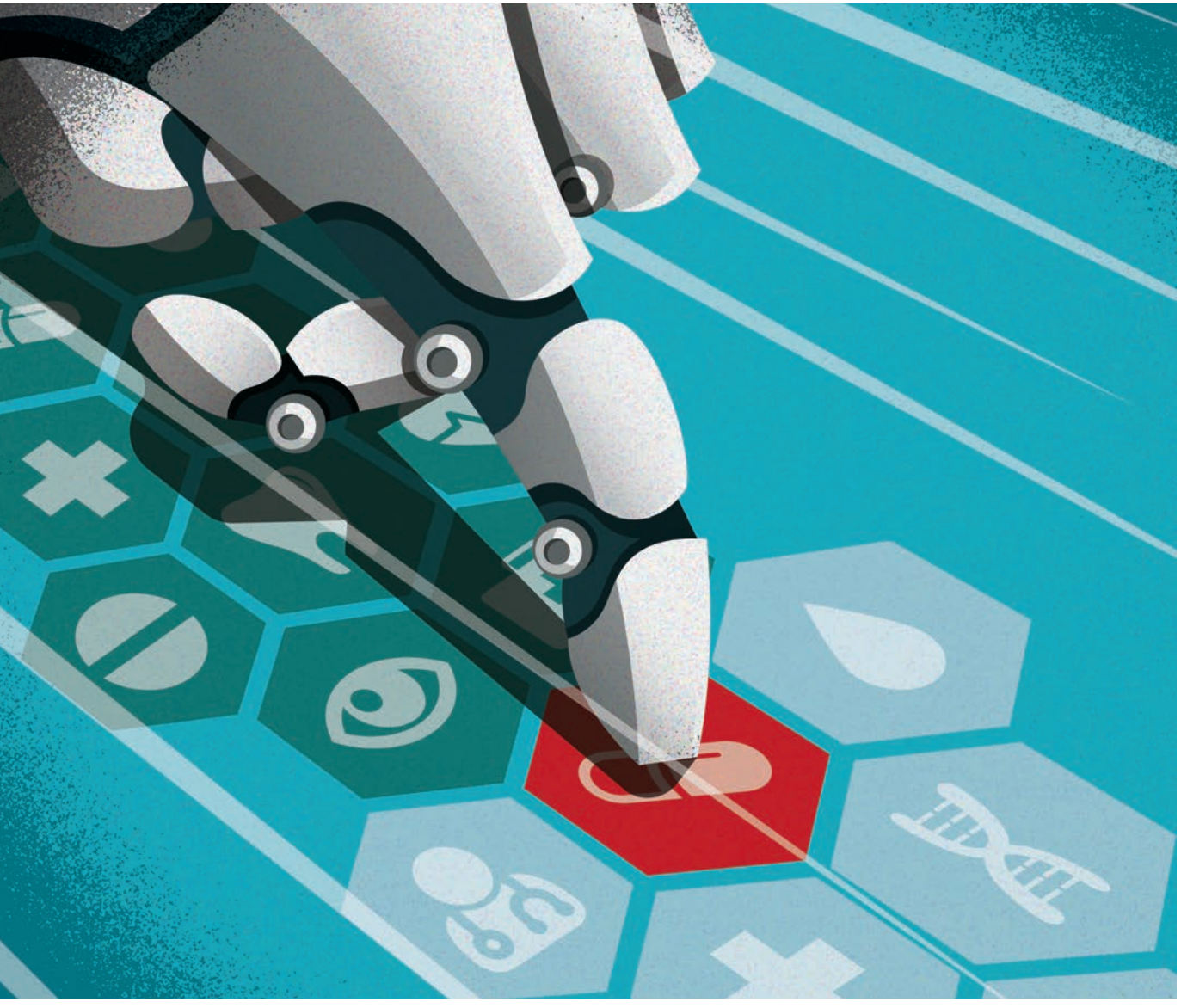
"Attackers are continuously changing their tactics. You have to look deeper into the connections of what's happening, what they're actually doing once they're inside, or when they're trying to get inside," Hamilton said. "The key is, as those specific behaviors change, to be able to identify that they've changed, that the intention is in fact malicious, and then be able to stop it as it's happening—rather than after you've already had personal emails published on the internet."

LOOKING FORWARD

Machine learning provides a direction for the future of cybersecurity, but it is unfortunately not a one-stop solution. As it happens, AI enables advancements in both cybersecurity and cyber attacks. Algorithms, for example, have been developed with the ability to write code to burrow past anti-virus scans. AI can also be used to quickly sweep the internet for personal information, perform mass phishing attempts, or spread fake video clips to influence public sentiment.

The ongoing pressure to develop better technologies will undoubtedly spark rapid innovation in the field, potentially instigating global shifts that have so far only been imagined by sci-fi narratives.

Though the technology has the capacity to both help and hurt, Hamilton is focused on a future in which AI is an uplifting agent. Hamilton's hope for an AI-enabled future? "To stop evildoers from stealing people's IP or from shutting down a hospital so that someone couldn't get their treatments," he said. "To know that we've made the world a little bit of a better place."



DISRUPTING DRUG DISCOVERY WITH AI

The current drug discovery pipeline discourages investing in medicines with smaller target populations. Some companies are using AI to accelerate the process and develop drugs for rare diseases.

by **Jon Lee**

HAVE YOU EVER heard of Wilson's disease? It is a rare genetic disorder with fewer than 20,000 diagnosed cases a year. Patients living with Wilson's disease cannot adequately eliminate copper from their body, which can be fatal.

Luckily, the treatment for Wilson's disease is simple.

Patients with Wilson's disease take a pill called Syprine three times a day. Until recently, Syprine was the only drug available to treat Wilson's disease because of the enormous investment associated with developing drugs and bringing them to the market.

Because of these costs, many of the largest pharmaceutical companies in the world spend minimal time on research for drugs that treat rare diseases. This lack of interest in making drugs for rare disorders means whoever owns the right to Syprine effectively has a monopoly.

Unfortunately for patients with Wilson's disease, a company named Valeant Pharmaceuticals purchased the rights to the drug and subsequently raised the price of a month's supply of medication to $21,267.

Valeant's overall philosophy, which landed them on an episode of the Netflix documentary series "Dirty Money," was to slash research and development budgets while raising the prices of proprietary drugs as high as possible.

While insurance overwhelmingly covers the costs of this drug, there is an additional layer to these type of drug price hikes which affects overall healthcare costs for everyone. When insurance companies have to pay through the nose for these drugs, they, in turn, pass those costs on to their subscribers which leads to everyone's health insurance premiums rising.

While there is justifiable outrage over the greed of pharmaceutical companies like Valeant, the real problem is that the drug discovery pipeline is broken. The costs of entry are too high, which leads to pharmaceutical companies thinking about their bottom line instead of their patients.

Unfortunately there did not seem to be an alternative to the current system—until recently, when breakthroughs in artificial intelligence and machine learning have given hope to the idea that these new AI-powered drug discovery companies might be able to disrupt the entire way drugs are discovered and brought to market.

IN THE UNITED STATES, it takes around 12 years and an estimated $684 million to $2.7 billion dollars to research, test, and approve a drug for distribution to pharmacies. Additionally, only about five out of every 5,000 drugs that enter preclinical testing get approved for testing on humans, and only one of those five drugs ever actually ends up on pharmacy shelves.

12 YEARS & $684 M – $2.7B

What it takes for a drug to make it to pharmacies

5 IN 5,000

Drugs that are approved to be tested on humans

1 IN 5,000

Drugs that make it to pharmacies

$10 M – $2 B

Cost to research and test one drug

<99%

Percentage of tested drugs that never reach the market

Since only one out of 5,000 potential drugs make it to market, drug manufacturers are incentivized to focus their drug discovery process on creating drugs that will quickly pay off their investment. The easiest way to do this is to develop drugs for diseases that are very common, like insomnia or depression.

With odds like this, it's a miracle that medicines for rare disorders such as Wilson's Disease even exist.

Currently, the enormous costs of researching, testing, and bringing a drug to market have made it so that only the largest and most well-funded pharmaceutical companies can afford to do it. The majority of these costs are spent on research as well as conducting studies to make sure that the drug is safe and effective to secure regulatory approval.

While the research and testing can cost anywhere between $10 million and $2 billion, what drives up the price is the fact that over 99% of the medicines tested fail to reach the market. These so-called "orphan drugs" may have unintended side effects, or only work with targeted genetic mutations.

Even an increase in effectiveness of 10% could represent a huge leap forward and would allow smaller companies without billions of dollars in funding to compete with the larger companies.

MANY GREAT COMPANIES are doing impressive work with AI at every step of the pipeline to make drug discovery easier, cheaper, and less time-consuming. Let's start at the beginning of the research and development phase.

As with all things AI, the process starts with data. Some companies in the drug discovery space are analyzing up to seven terabytes of rich biological information a week.

There are three steps for analyzing these massive datasets:

The first step is mapping human biology down to the genetic level. For example, a panel test on one person's genome will document 200 to 500 genes, with special

attention to mutations and molecular variations that cause disease. However, exome sequencing (which is of particular interest to drug researchers), examines 20,000 genes that code for proteins. And when the entire genome is sequenced, each individual has more than 3 billion base pairs of DNA. That's a massive amount of data to be sorted and analyzed.

The second step is to investigate and map the genetic associations of certain diseases, such as Wilson's disorder. Every disease has different genes implicated in it, and the model has to learn how those diseases develop both hereditarily and otherwise to make predictions about treatment.

The third step is analyzing and mapping drug compounds known to treat these and other diseases. Once the model has this data, it should be able to bring in different chemical structures to see if it can predict specific biological signatures and treatment options.

This information is invaluable for discovering which drugs could potentially treat which conditions, eliminating hundreds if not thousands of hours of research by humans. This approach can also find patterns and links that might escape traditional medical research staff.

A good analogy to this process is how Google developed Google Earth, then Google Maps. The satellite images needed for Google Earth are like the map of the human genome, as well as diseases. That information is necessary to then extrapolate the best route to a precise location on Google maps. The directions, or how you get from point A to point B, is like the information about various drug compounds. Once the Google model has both the satellite images and the location, it can analyze multiple factors, like traffic and closed roads, to find the best route.

In the next three to five years, AI-based drug discovery companies are betting that their models will be able to take the information on genes, diseases, and chemical compounds and sift through the data to find the most effective drugs for treatment using a similar machine learning process.

As with all discoveries, the easiest way to validate this kind of science is to rediscover things that we already know. One company, Recursion Pharmaceuticals, has already successfully mapped the molecular properties underpinning more than 100 diseases in the last quarter alone, substantiating this type of research.

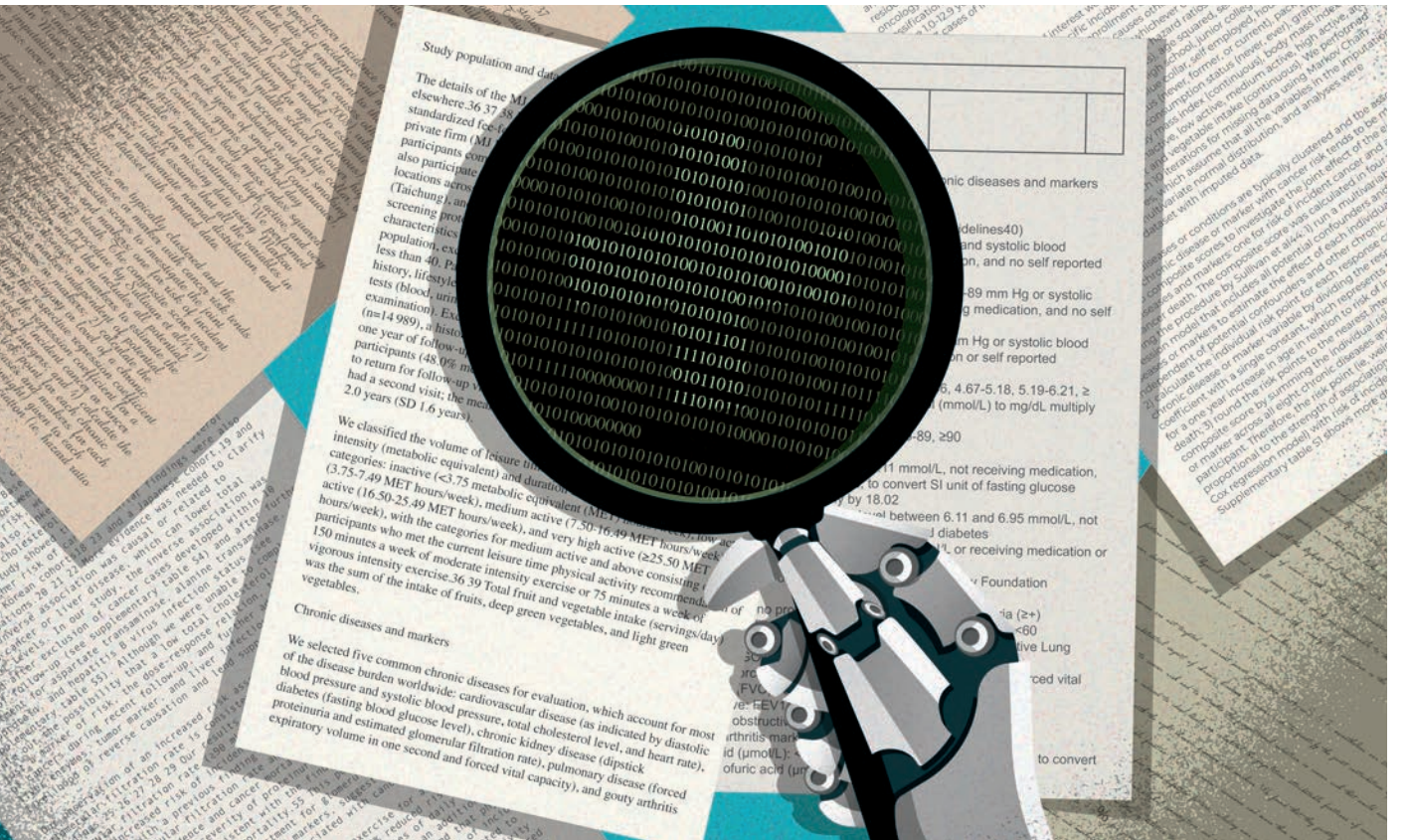
THE CURRENT DRUG discovery process is broken.

Because of the cost of drug discovery, bigger companies aren't interested in creating cheaper drugs for rare diseases like Wilson's disease. This leads to monopolies on those drugs like we saw earlier with Syprine—and those costs get passed onto the average person through higher insurance premiums.

Artificial intelligence presents a potential solution to this problem.

By analyzing terabytes of data, AI companies are mapping the human genome, the genes implicated in disease, and the chemical compounds found in the drugs used to treat these diseases. By capturing this massive data set, machine learning models could then use this data to create hypotheses for drug treatment, eliminating the need for traditional research and allowing companies to skip directly to the testing and regulation phase of the drug discovery process. It is also believed that as these models continue to learn, they will be able to increase the accuracy of drug hypotheses leading to much better approval rates than the current rate—a dismal 0.0002%.

By cutting down on the expense and time necessary to bring safe and effective drugs to the market, AI has the potential to disrupt the drug discovery process—and maybe even the entire healthcare system.



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THE HUMAN ELEMENT

SCI-FI NARRATIVES OFFER INSIGHT INTO THE FUTURE OF CONFLICT

As the world races to implement AI in military applications, the defense community is getting ideas for future tech from an unlikely source: science fiction writers.

by **August Cole**

SCIENCE FICTION WAS a leading indicator for invention and innovation during the 20th century, particularly during periods of profound technological and social change. It served as both commentary and inspiration after World War II, through the Cold War, and in the 1990s, when the advent of the Internet began to further narrow the gap between fiction and reality.

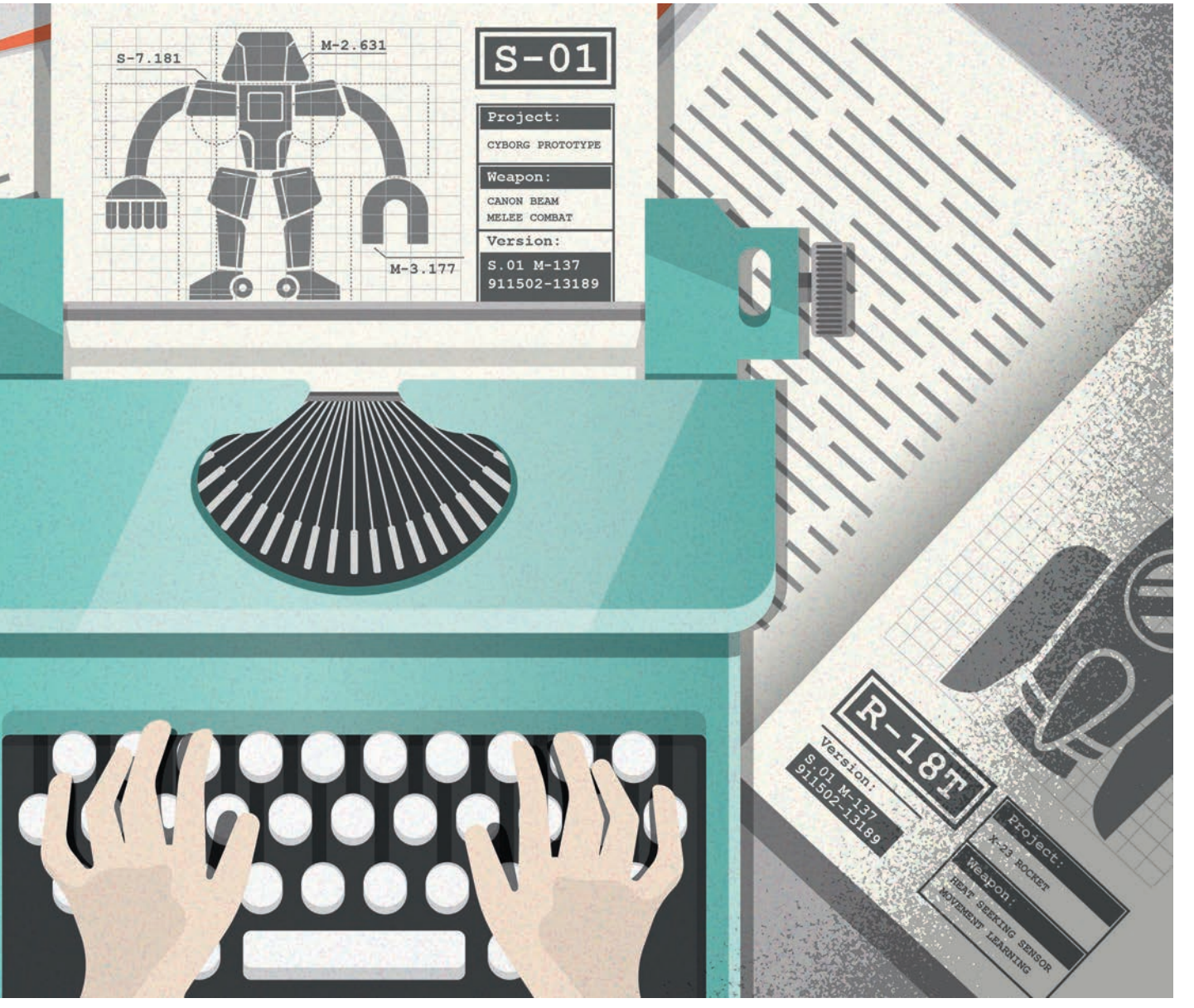
Technology that once only existed in the minds of science fiction writers—domestic robots, printing physical objects, global information networks—has now become reality. However, beyond fantastical inventions, science fiction's narratives often contain a statement on society, humanizing problems and decisions. With this in mind, the defense community has begun to seek out the imagination of writers to test assumptions, stoke wild ideas, and ferret out unseen risks.

We have to understand that unconnected technological innovations or breakthroughs can emerge simultaneously with other game-changing societal and political shifts. A holistic vision of the future should account for this complexity. As an example, a view of the Jet Age would be incomplete if it focused solely on the DC-8 and Boeing 707 and excluded the Civil Rights movement gaining strength with the Montgomery Bus Boycott. More recently, social media platforms like Facebook helped empower restive populations in the Middle East and North Africa at the same time that bitcoin was starting to gain traction.

Looking forward, generational breakthroughs in AI research and implementation are underway in the U.S., Europe, and China at the same time that algorithm-driven gig work is growing globally and "once in a century" weather events are regular occurrences around the world. While no narrative is a perfect forecast, encompassing disparate elements can render a more honest, and compelling, picture of the future.

From storytelling, we can also understand technology as an expression of the human experience, not the other

> **"SEEING A FUTURE WORLD THROUGH THE SENSES OF A CHARACTER—HERO OR VILLAIN—LETS THE READERS ENGAGE ON AN EMOTIONAL LEVEL WHILE ALLOWING RATIONAL CONSIDERATION OF HOW LIKELY A CERTAIN TURN OF EVENTS MIGHT BE OR WHETHER THE INTRODUCTION OF A NEW TECHNOLOGY MAY DO MORE HARM THAN GOOD.**



way around. A definitional movie like "The Terminator" continues to influence conversations about existential risks posed by AI and robotics. However, the 2013 Spike Jonze film "Her" about how an intelligent mobile operating system can fill a profound emotional gap is perhaps more important for understanding the future of conflict, because it focuses on the intense bonds that will certainly develop between humans and sentient machines.

Technological innovation often has the potential for an unfortunate dark side, particularly in conflict. The flying cars promised by The Jetsons could be hacked and armed for close-air support. Elementary schoolers calling their parents from a wristwatch creates a technological tether that adversaries could exploit for intelligence collection or worse. Storytelling allows an exposition of risks, freed from boundaries inherent in traditional analysis or modeling.

Using creative narratives also permits testing of hypotheses before the stakes get highest, like during a conflict, from a relatable, character-driven point of view. Traditional scenario development or wargaming does this too, but often fails to give a ground-level perspective that can unlock crucial insights.

Seeing a future world through the senses of a character—hero or villain—lets the readers engage on an emotional level while allowing rational consideration of how likely a certain turn of events might be or whether the introduction of a new technology may do more harm than good. In the balance between dystopian and utopian narratives, we confront our own biases and assumptions about what the world holds in store by joining the writer in the world-building.

Exploring the duality of technology is a central challenge as government and industry look for fresh insight into basic questions of what exactly war will look like. There is a mounting list of advances capable of destabilizing the international security environment, from tweets that might start wars to fake propaganda swaying entire populations to backroom gene-editing breakthroughs. These tools that do not follow the cloistered development pathways of traditional military technologies can particularly benefit from the understanding conveyed by short stories.

Even organizations as large and complex as the Department of Defense are seeking out creative thinking to prepare for the future. In 2016, the Marine Corps Warfighting Lab commissioned Marines to write sci-fi short stories in order to showcase its futures forecasts. That same year, Deputy Secretary of Defense Robert O. Work's office entertained an Atlantic Council Art of the Future short story contest to explore the Third Offset Strategy. Finally, the U.S. Army Training and Doctrine Command's Mad Scientist Initiative regularly taps writers such as "World War Z" author Max Brooks to help figure out what the coming decades hold.

This embrace of fictional narrative is having its moment because of a growing recognition that relying on status quo approaches to foresight creates strategic vulnerabilities. Former Chairman of the Joint Chiefs General Martin Dempsey recently wrote of the anthology "Strategy Strikes Back: How Star Wars Explains Modern Military Conflict," "Over the course of history, our single greatest vulnerability has been a failure of imagination... Learning to imagine now will be time well spent."

If enjoyable science fiction and narrative are to be taken seriously as a tool (who among us hasn't claimed that the video game they are playing is for work), that means keeping in mind some simple guidelines about how it can best be used.

It's worth remembering that any one story is a starting point in a discussion about what the future holds, rather than a crystal-ball prediction. New voices and differing viewpoints, including from authors abroad, also hold particular value. Take, for example, China's Liu Cixin who wrote the "The Three Body Problem" trilogy about first contact with malevolent aliens. As a sci-fi tale it is remarkable, but it contains unique insights about everything from strategic weapons acquisitions to risks of the Internet of Things.

Of course, science fiction is just one tool in the foresight toolkit. When we look back with decades of hindsight at the myriad technological, social, and economic changes underway right now, it is likely the current crop of science fiction narratives will miss a critical breakthrough or a groundswell of movements starting to shape the security environment of the next decade. But we need not be blindsided, because we have made science fiction and narrative foresight a staple of considering what lies ahead.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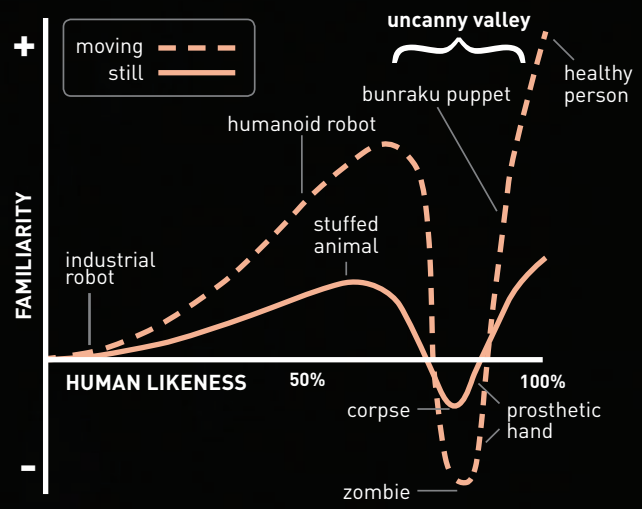
WHY DOES THIS ROBOT FACE CREEP ME OUT?

Despite progress in design and animation, computer-generated faces usually resemble cartoons rather than actual humans. While creating realistic faces in animations may seem desirable, research shows this is anything but the case.

by **Marla Rosner**

IN A 1970 ISSUE of a little-known Japanese magazine called Energy, roboticist Masahiro Mori first coined the term "bukimi no tani"—literally, "the uncanny valley." He explained that objects, such as robots or toys, become more endearing as they become more human-like. However, at a certain threshold of human likeness, the object turns creepy and off-putting. Make the object even more realistic—to the point of being indistinguishable from real humans—and it becomes likeable again.

Mori charted this progression in human perception, and named the point where objects were considered creepy the "uncanny valley."



▲ **MASAHIRO MORI'S 1970 CHART OF THE UNCANNY VALLEY**

Mori recognized that it was risky, and possibly not realistic, to build robots with sufficient human similarity as to meet the second peak. Thus, he recommended designers focus on the first, with "a moderate degree of human likeness and a considerable sense of affinity."

◀ **TELENOID R1 TELEPRESENCE ROBOT, DEVELOPED BY OSAKA UNIVERSITY**

source:
www.cnet.com/news/loneliness-narrows-the-uncanny-valley/

ARTIFICIAL HUMANS, REAL IMPACT

The idea of the uncanny valley took a long time to enter the popular consciousness. When Pixar created the short film "Tin Toy" in 1988, they had likely never heard of Mori's work—but they wound up experiencing it firsthand anyway. "Tin Toy" was certainly a success, winning the first Oscar for a work of CGI animation (and Pixar's first Oscar). But while the titular toy soldier was beloved, its co-star—a human baby named "Billy"—was anything but. Audiences reacted with overwhelming negativity to the character. In "Pixar Short Films Collection: Volume 1," one commentator referred to the baby as "the most frightening and disturbing piece of animation in the history of this art form." Sound extreme? Meet Billy, pictured right.

The audience response to Billy was a turning point for the fledgling computer animation industry. In an interview with Scientific American, Thalia Wheatley, a researcher at Dartmouth College who has worked on the uncanny valley, commented, "Pixar took a lesson from 'Tin Toy.' We have to nail the human form or not even go there."

▲ BILLY FROM "TIN TOY"
source:
www.imdb.com/title/tt0096273/mediaviewer/rm3826469376

In the following years, Pixar's much-adored films starred bugs, toys, cars—anything but humans. It wasn't until 2004's "The Incredibles" that Pixar attempted a movie with a principal cast of humans, and the design differences between Billy and the new superheroes were striking.

▲ THE CENTRAL CHARACTERS OF "THE INCREDIBLES"
source:
www.pixarplanet.com/blog/the-incredibles-2-update/

Unlike Billy, the Incredibles don't even attempt realism. Their proportions are not remotely human; instead, they're exaggerated to the point of ridiculousness. But they also are far more pleasing to the eye.

Pixar's trend against realistic human proportions still continues. In the 2017 film "Coco," young Miguel Rivera's eyes are cartoonishly oversized, his face too round, his head disproportionately large. Yet he is instantly appealing to viewers.

Whether they've read Mori's original article or not, it's clear Pixar has arrived at the same conclusion: Realistic human facsimiles are best avoided.

However, with the growing prevalence of AI and robotics in society, this may no longer be an option. As robotic systems become part of our daily lives, the uncanny valley no longer presents a problem only for animators. Robots are poised to be—and in some cases, already are—our assistants, companions, teachers, and playmates. Whether it's Alexa keeping track of your grocery list or the Nao robot helping autistic children learn about social interaction, this technological revolution has a lot to offer in terms of human interactions.

▲ MIGUEL FROM THE 2017 FILM "COCO"
source:
www.nme.com/news/film/watch-the-first-trailer-for-disney-pixars-new-music-themed-film-coco-2019286

But none of these possibilities can be realized if these robots make their human counterparts uncomfortable. For humans to get the most out of robots, they need to be able to form bonds with them, not be frightened of them. And people just aren't as willing to work with robots that look like the one pictured below.

▲ TELENOID R1 TELEPRESENCE ROBOT, DEVELOPED BY OSAKA UNIVERSITY
source:
www.geminoid.jp/projects/kibans/Telenoid-overview.html

THE SCIENCE BEHIND THE UNCANNY VALLEY

To overcome this problem, we first need to understand how it works. Why is the image on the right so much more appealing than the far more humanistic one that is to the right of it?

As of yet, there are many ideas but no clear consensus. The scientific community has long debated the workings of this phenomenon. Evidence shows that this effect is consistent across cultural lines, but the reasons behind it are less clear. Ayse Saygin, a cognitive scientist at the University of California, San Diego, is cited by Scientific American as saying, "This is one of those cases where we're at the very beginning of understanding it."

Still, as academic interest in the topic has intensified, a number of prominent theories have emerged. Saygin, along

with many other researchers, believes that the uncanny valley effect occurs because when an artificial figure reaches a certain threshold of human approximation, our brains start looking at it as a potential human. Inevitably, however, the artificial figure is unable to withstand this closer level of scrutiny.

In other words, Nao can act however it wants because it looks cute without actually looking human. Repilee, pictured below, is subject to human standards, and no robot yet created can measure up.

It's possible that overly humanoid robots set off alarm bells in viewer's heads because, when judged as humans, they deviate subtly from expectations of how humans should interact and socialize. Humans are intensely social as a species, and extremely keyed-in to minor social cues. These deviations are therefore upsetting and disturbing.

Humans may also be repulsed by figures in the uncanny valley because we have evolved to avoid defects that could potentially indicate disease, or at the very least, infirmities that would make for a poor mate selection. "Evolutionary history has tuned us to detect minor distortions that indicate disease, mental or physical problems," explains Wheatley. "To go after a human-looking robot or avatar is to go up against millions of years of evolutionary history."

▲ COMMANDER SHEPARD FROM THE VIDEO GAME MASS EFFECT 3
source:
www.hobbyconsolas.com /noticias/mass-effect-3-sera-el-adios-de-shepard-19675

◀ NAO, A ROBOT FROM ALDEBARAN ROBOTICS
source:
www.robotlab.com/store/nao-power-v6-educator-pack

▲ REPLIEE Q2, DEVELOPED BY OSAKA UNIVERSITY
source:
www.buzzfeed.com/danmeth/welcome-to-uncanny-valley?utm_term=.cqPgALo7W#.qnG5oNnZD

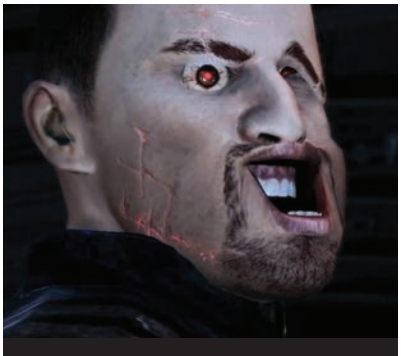
SO WHERE DO WE GO FROM HERE?

Despite this, we know for certain that one of the best ways to create productive human-robot interaction is to make robots more like people. More humanoid robots are able to engage with us in natural and familiar ways, including facial expressions, eye gaze, and body movement. We naturally gravitate towards these likenesses because they are familiar to us and inspire empathy and fondness.

But how can we do that without falling into the unforgiving ravine of the uncanny valley? It's possible that as technology progresses, manufacturers will increasingly be able to create robots lifelike enough to pass beyond the uncanny valley. Some researchers even suggest that as future generations grow up surrounded by robots, the effects of the uncanny valley will decrease.

Others, however, wonder if the opposite won't occur instead. According to a 2011 University of Bolton study by Angela Tinwell, Mark Grimshaw, and Andrew Williams, humans may become more sensitive to increasingly subtle cues that indicate a robot is not human as robots become more realistic. Does this mean that the only answer is still the original one proposed by Mori in 1970, to only create designs that are obviously non-human?

At present there are no clear answers, except that more research is still needed. So for now, I'll leave you with this.



source:
https://www.youtube.com/watch?v=JxhBC7dsUBA

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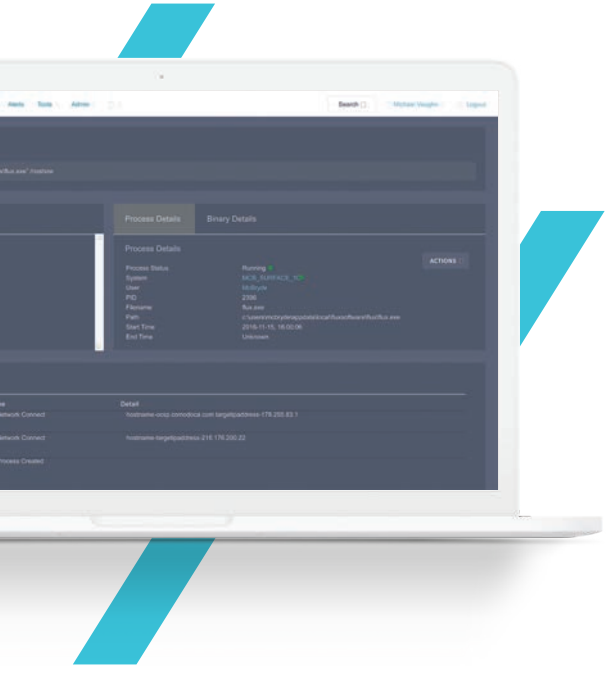

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