trajectory

THE OFFICIAL MAGAZINE **OF THE UNITED STATES GEOSPATIAL INTELLIGENCE FOUNDATION**

The Vanguard
of
Commercial
GEOINT

From self-driving cars and "drones as a service" to crowdsourcing exercise routes, the commercial world continues to leverage GEOINT in new and creative ways

> The Algorithm Age
> Q&A: Jeff Jonas

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contents

IMAGE COURTESY OF MAPD

This screenshot of MapD's live Tweetmap visualization shows the most recent two weeks of data, with approximately 400 million tweets cached for exploration.

@Awarewolf_Magic Fri Dec 01 2017
I need to get back to watching hockey

TRJ-053

ON THE COVER:
Strava's Global Heatmap displays water activities such as swimming, surfing, and kayaking in Sydney, Australia. Strava is one of four companies on the leading edge of commercial GEOINT featured in this issue's cover story.
Image courtesy of Strava

GEOINT's Expanding Applications

As we embark upon 2018, despite utterly frigid cold here in the northeast United States, the GEOINT field remains hot. The GEOINT Revolution continues to churn at what seems to be an exponential pace. Rapidly advancing technologies and ever-evolving applications across increasingly diverse sectors demand that GEOINT professionals continuously seek to enhance existing skill sets and add new ones.

For 14 years, USGIF has led the charge for the creation of GEOINT opportunities in higher education, and for creating myriad avenues for professional development. Though we

^ *Graphic facilitation being conducted during USGIF's 2017 GeoAcademic Summit at the Foundation's headquarters in Herndon, Va.*

have a strong record of accomplishment in these areas, in some ways I feel the Foundation is just beginning to hit its stride, and our capacity continues to grow.

The beginning of 2018 brings another GEOINT Community Job Fair, the newest installment of the State and Future of GEOINT Report, another fantastic small satellite event, informative and engaging GEOINTeraction Tuesday gatherings, and rich discussions fostered among USGIF committees and working groups.

All of this is made possible thanks to our organizational and individual membership programs, advertising via our multimedia platforms, and revenue from events—including sponsorships, advertising, exhibits, and attendee registrations. Additionally, USGIF's EdGEOcation Giving Campaign has opened up an important opportunity for philanthropic support.
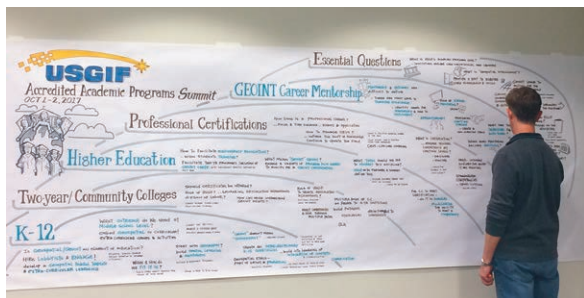
If you and your organization have benefitted from USGIF over the years, then please consider the many ways in which you can give back so we may continue our work as the convening authority for GEOINT Community discussions as well as our enduring support toward thought leadership. We value your participation in our events, your time devoted to our working groups, your investment in membership and sponsorship, and your charitable donations. We remain thoughtful stewards of the resources you entrust to us. The Foundation's work is more important than ever as the concept of GEOINT rapidly expands.

This issue of *trajectory* speaks quite clearly to that expansion. The commercial GEOINT cover story provides four case studies that illustrate the application of GEOINT to challenges and opportunities outside the traditional national security arena. A second feature documents the transition of machine learning from the theoretical to the applied within the defense and intelligence communities. And on our website, you will find a web exclusive profiling the critical but little-known Safety of Navigation mission at the National Geospatial-Intelligence Agency.

Best wishes to all for a healthy, happy, and rewarding 2018. As always, I eagerly look forward to seeing you in our conference rooms and hallways, in and around your workplaces, and at our events—to include our return to Tampa in April for the GEOINT 2018 Symposium.

KEITH J. MASBACK | CEO, USGIF
@geointer

LETTER TO THE EDITOR

Dear *trajectory* team,

Andrew Foerch presented a concise narrative of the Google Earth trajectory ("The Genesis of Google Earth," 2017 Issue 4). Missing, however, was the inaugural 2001 contract with Keyhole Inc. by the United Nations Environment Programme (UNEP). This inaugural UNEP contract represented the Keyhole team's first and important milestone.

This achievement formally and visibly put these gentlemen on the international stage at both the International Conference on Spatial Information for Sustainable Development, October 2001, Nairobi, Kenya as well as the World Summit for Sustainable Development, August 2002, Johannesburg, South Africa. This grand debut into the global civil society, outside the military-industrial society, demonstrated the potential of "digital Earth" technology for managing and preserving the Earth's ecological goods and services as well as effectively addressing disaster response and resilience.

The UN, along with myriad organizations and citizens, has followed this trajectory toward using spatial science and information for improving the human condition and protecting our biosphere.

Keep up the great journalism.

—*Dr. Tim Foresman, International Center for Remote Sensing Education*
(Dr. Foresman was UNEP's chief scientist responsible for initiating the Keyhole Inc. contract, and the former Digital Earth chairman for NASA.)

👥 USGIF WORKSHOP SERIES

Achieving Accurate, Reliable AI

^ *From left to right, Machine Learning & Artificial Intelligence workshop panelists Dr. Darryl Murdock, Dr. Todd S. Bacastow, Dr. Curt H. Davis, and Melissa Planert.*

USGIF's Machine Learning & Artificial Intelligence Working Group gathered dozens of experts for its November workshop to explore the opportunities and challenges intelligent technologies present. The daylong session at the National Geospatial-Intelligence Agency (NGA) attracted more than 275 people and was one of many events hosted as part of USGIF's GEOINT Community Week.

In the first panel on the implications of machine learning for GEOINT professionals, Melissa Planert, director of NGA's Office of Analytic Tradecraft, said it's not hard to imagine a time when analysts won't be able to work with all of the data available to them. Planert predicted computer vision would be most important for the GEOINT Community.

Planert said AI presents the possibility for around-the-clock analysis that identifies patterns of life and trends, and can also enable anticipatory intelligence. She also outlined what analysts will expect from AI tools, including: an intuitive user experience, a simple feedback mechanism to train algorithms, increased accuracy over time, alert mechanisms, confidence metrics, and metadata tagging.

Dr. Curt Davis, director of the Center for Geospatial Intelligence at the University of Missouri, said AI is still in the early stages, but warned the United States is trailing behind the rest of the global community. Davis personally catalogued articles on deep learning in three IEEE remote sensing journals from 2015 to 2017. He discovered that out of approximately 100 articles, 71 percent were authored by China, while 11 percent were authored by European nations, the rest of the world authored 13 percent, and only five percent originated from the U.S.

💬 To learn more about USGIF's Machine Learning & Artificial Intelligence Working Group, visit **usgif.org/ community/committees/ machinelearning**.

PHOTO COURTESY OF NGA

David Aha, lead of the Naval Research Lab's Adaptive Systems Section, said there are currently many common concerns that AI technologies are opaque, unreliable, corruptible, spoofable, and overhyped.

William "Buzz" Roberts, director of automation, artificial intelligence, and augmentation at NGA, said conversations about how, where, and when to appropriately create training data as well as to test and implement AI aren't occurring enough. He suggested rather than broad implementation, each mission should take its own approach to reach information assurance.

Regarding overhype, Roberts said, "There's a huge set of misperceptions that 'We can automate that.' We need a deep level of understanding by all parties to get to 98/99 percent reliability."

Dawn Meyerriecks, the CIA's deputy director of science and technology, gave an afternoon keynote in which she also warned about hype, describing AI as "emergent."

"One in 30 companies that claim they're doing machine learning and AI today are actually doing it," she said.

Meyerriecks added she sees much potential for AI, but warned against ruining the technology's reputation by over-promising and under-delivering.

USGIF's Young Professionals Group (YPG) hosted a holiday cruise on the Potomac River, and collected new gifts for Toys for Tots while onboard.

YPG

Young Professionals Give Back

In support of George Mason University's (GMU) GIS Day events, members of USGIF's Young Professionals Group (YPG) spoke on a panel to current GMU students enrolled in geospatial science courses. Participants included Heather FitzGerald, NGA; Justin Franz, USGIF; Ian Harvey, Pricewaterhouse-Coopers; and Robert Miller, HawkEye 360. Each panelist shared their career journeys and advice on pursuing opportunities in the GEOINT Community. Following the panel, YPG continued the conversation at a networking reception sponsored by Boundless.

YPG celebrated the holidays in December with a chartered cruise on the Potomac River. Members had the opportunity to enjoy the holiday season while taking in views of Washington, D.C. While onboard, the group also collected new gifts for Toys for Tots.

PROCRASTINATION TOOLS

DOT
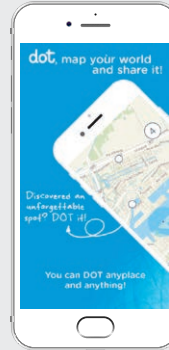
Map and share your world with DOT. Users drop "dots" to mark places they've visited on the app's base map, labeling the locations with hashtags and comments for friends and visitors. Anything can be a dot, from bathrooms to ice cream parlors—when you are done placing dots, the app creates a unique map file from your entries. Use cases range from finding and reviewing bakeries to creating a personal list of your city's best views.
dotisfun.com

Map of Life
Explore global biodiversity and learn about your favorite flora and fauna with Map of Life. This database covers 30,000 species worldwide and includes trend indicator maps, species range maps, location-based wildlife maps, lists, and more. Users can record their own observations in the app and share them with friends and other researchers. The tool is perfect for the outdoorsman or nature enthusiast looking to forgo bulky guidebooks.
mol.org
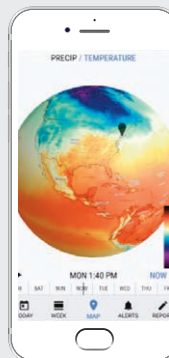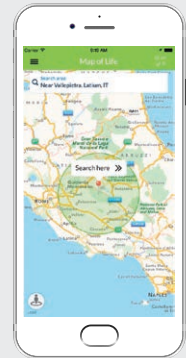
Dark Sky
Dark Sky uses GPS technology and predictive analytics to provide an accurate, hyperlocal weather forecast for exactly where you stand. Whether it's light rain beginning at precisely 12:05 p.m., snow in an hour, or hurricane-force winds this weekend, minute-by-minute notifications alert users to the information they need. The app features fluid radar animations the user can drag back and forth to view a storm's progression, as well as global weather maps for precipitation and temperature.
darksky.net/app

![EdGEOcation icon] **EdGEOcation**

USGIF Shares GEOINT with 800+ Students During GEOINT Community Week

^ *USGIF Intern Madalyn Caraway (left) volunteered at a GeoPlunge tournament in Washington, D.C., where more than 100 students played the geography card game.*

USGIF participated in many K-12-focused activities in November as part of the Foundation's GEOINT Community Week, which coincided with Geography Awareness Week.

Throughout the week, USGIF volunteers gave Intro to GEOINT presentations at schools across the U.S. and Canada.

USGIF also created a pilot Intro to GEOINT curriculum for Kilmer Middle School in Vienna, Va. Each week over a three-month period, eighth grade students learned about a different GEOINT topic along with an interactive activity.

Additionally, USGIF sponsored and participated in Geo-Plunge tournaments in Washington, D.C., and St. Louis. The GeoPlunge card game teaches geographic literacy in a fun way.

USGIF also held a satellite imagery analysis activity at two community STEM events—Moorefield Station Elementary School's STEM Night in Ashburn, Va., and Women In Technology's "Girls In Technology Sharing Our Success" event in Washington, D.C.

The American Geographical Society (AGS) hosted an invite-only AGS Geography Teacher Fellows Program for around 50 AP Human Geography teachers Nov. 18. USGIF Director of Academic Programs Dr. Camelia Kantor moderated a panel—"So, What's in it for the Students?"—which provided teachers more insight on career opportunities in geography and geospatial sciences as well as resources for curriculum development.

> *Moorefield Station Elementary School in Ashburn, Va., held its annual STEM Night, at which USGIF provided a satellite imagery analysis activity.*

NOVA IMS Receives Third Party Accreditation

The NOVA Information Management School (IMS) at the Universidade Nova de Lisbon received a six-year accreditation for its online master's degree program in geographic information systems and sciences by the Agency for Assessment and Accreditation of Higher Education (A3ES). A3ES is a private, third-party accreditation body in Portugal. NOVA IMS became accredited by USGIF in 2016 and is the first non-U.S. school to achieve USGIF academic accreditation.

GEOINTeraction

The AI Arms Race

The United States, China, and Russia are "in an arms race for artificial intelligence," according to Dr. Anthony Vinci, NGA's director of plans and programs.

Vinci discussed the importance of preparing for the future in front of a crowd of more than 100 people in November at USGIF's GEOINTeraction Tuesday event, hosted by OGSystems in Chantilly, Va.

Vinci pointed to recent reports in which Russian President Vladimir Putin claimed the leader in AI would be "the ruler of the world." Meanwhile, he said, China is planning to turn AI into a $150 billion industry by 2030.

"There are these real threats, and they're not necessarily just the ones we've grown used to since 9/11," Vinci said, emphasizing the importance of dialogue about the future among NGA, the broader Intelligence Community (IC), industry, academia, and organizations such as USGIF.

"There's a real possibility the U.S. could become second best—that we could lose some of these arms races," he said. "We have all grown up in a world in which, by far, the U.S. was the dominant GEOINT capability, even before it was called GEOINT. We can't even imagine a world in which we aren't, but it's a possibility, and we need to confront that possibility and ensure it doesn't happen. We need to remain dominant."

Vinci outlined emerging technologies with the potential to help the U.S. maintain intelligence dominance, including commercial space advances, the Internet of Things (IoT), and autonomous vehicles. He added it's important the IC confront not just how it will take advantage of these new technologies, but also how adversaries might leverage them.

"We have to prepare for a world where a country like China might try to dominate AI, where terrorists have UAVs and other autonomous vehicles they can use for attacks, where Russia might use IoT devices or other things for spying in our country, and where lots of countries and even non-state actors have access to space," Vinci said.

In some cases, he said, these things are already happening. Vinci concluded with a quote from writer William Gibson: "The future is already here—it's just not evenly distributed."

^ *Dr. Anthony Vinci, NGA's director of plans and programs, spoke about the future at USGIF's GEOINTeraction Tuesday event in November.*

> China is planning to turn AI into a **$150** billion industry by 2030.

University of Missouri AI Research Identifies Missile Sites

Researchers from the University of Missouri's CenterforGeospatial Intelligence published an article in the *Journal of Applied Remote Sensing* in October that evaluated how deep learning algorithms can identify missile sites. The group sifted through 70 terabytes of DigitalGlobe satellite imagery combined with surface-to-air-missile sites in areas of China to test four deep learning models and determine which one performed best. This research was created as a way to automate the process of examining imagery for undeclared nuclear facilities or secret military sites.
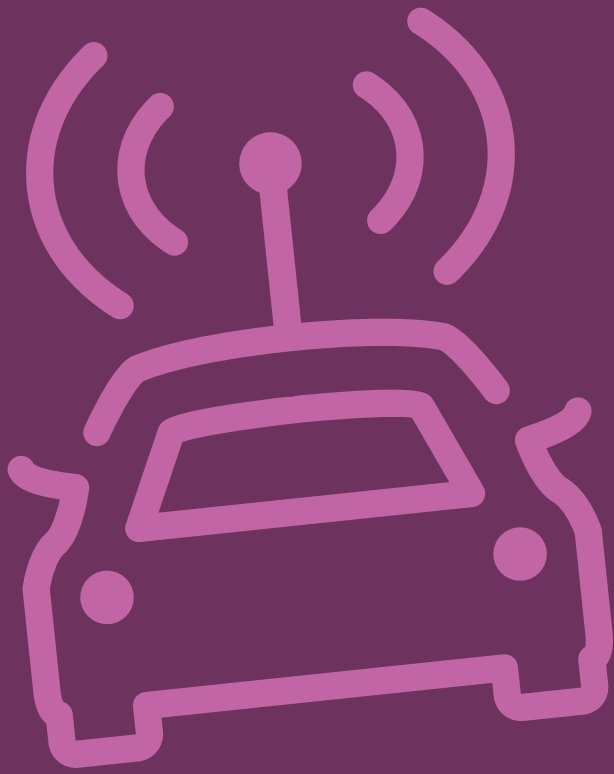
From self-driving cars and "drones as a service" to crowdsourcing exercise routes, the commercial world continues to leverage GEOINT in new and creative ways

the Vanguard

BY ROB PEGORARO

of commercial GEOINT

FIRST WE TOLD OUR DEVICES how to locate themselves, then we gave our computers the power to parse the profusion of data those devices generate. Now, those devices are returning the favor by providing useful information about the world around us. But many of us have only begun to realize all the possibilities these changes have opened after creeping up on us from multiple directions.

"We sort of slouched into it," said Dr. Todd S. Bacastow, a professor of practice at Pennsylvania State University. "It's certainly been within the last five to 10 years that we've begun to see this massive amount of data and all the opportunity within it."

Around 25 years ago, only approximately 15 percent of the information collected in the world was geo-tagged, observed Dr. Steven D. Fleming, a professor of spatial sciences with the University of Southern California's Spatial Sciences Institute, which is accredited by USGIF to grant academic GEOINT Certificates.

Now? "Most of the world's data is geo-tagged—I think it's 85 to 90 percent," Fleming said. "We know where a banking transaction starts and where it ends. We can track digits. We can certainly track where people are."

That's the story of how geospatial intelligence (GEOINT) has generated new perspectives on the natural and built environment. But the next chapter—how companies take these possibilities and turn them into new products and services—includes many plot twists.

These four companies illustrate only a few of many ways the commercial world is leveraging the power of GEOINT.

Digital maps save consumers **21 billion hours** per year as a result of faster, better informed shopping decisions.

Teaching Cadillacs to Drive Themselves

The form of GEOINT many people know best is the digital map—for example, the latest Geography 2050 conference in New York City focused entirely on mobility. The ability of a phone to locate itself and then offer directions customized to traffic conditions was the stuff of science fiction 30 years ago. But as impressive as the digital cartography of Google and others can be, it's not precise enough to feed directly to a self-driving vehicle.

So Cadillac decided to commission its own maps before it could include its highway-only Super Cruise self-driving option in the 2018 CT6. The carmaker turned to a Livonia, Mich., firm named Ushr to take navigational mapping to the next level.

"The difference about an autonomous driving map versus a navigation map, we're concerned about the lane delineators, the slope of the road," said Chris Thibodeau, senior vice president of Ushr. "In a navigation map, none of that information is needed."

Plus, an autonomous driving map needs accuracy beyond what GPS can deliver—down to 10 centimeters. Ushr sent cars packed with LiDAR sensors on a tour of America's highways—220,000 miles driven since 2013.

"It took us about a year and a half to collect and process all that data," Thibodeau said.

In September, I had the opportunity to take a CT6 on loan from Cadillac for a test drive from Washington, D.C., to Cleveland, and the results were a kind of magic: Once the CT6 recognized it was on a highway in its database, a steering-wheel icon lit up on the dashboard to advise me that Super Cruise was available. I'd press a button to activate this mode, and the top of the steering wheel illuminated in green to show the car had taken over.

Informed by its database, the CT6 stuck to a lane as if it were a rail, slowing and accelerating as needed to compensate for traffic around me. All I had to do was keep my eyes focused on the road ahead—something the car itself watched for, using an inward-facing camera to ensure I was still paying attention.

Ushr is now looking to drive down the costs of its mapping solution, in part by applying machine learning techniques to recognize road features such as stop signs and crosswalks.

"We're also spending a good amount of engineering resource today on basically automating those feature identification and feature extraction algorithms," said Brian Radloff, Ushr's vice president of business development. He added this would allow Ushr to begin mapping secondary roads.

Cadillac might not need that data—company president Johan de Nysschen told me in 2016 that bulky LiDAR sensors needed to detect pedestrians would not fit with a Cadillac's style—but Ushr has other customers in mind.

"Some municipalities are looking at potentially using this data [in place of conducting their own surveys] if it's accurate enough," Radloff said. "When Amazon's talking about things like drone delivery having a very precise HD map those drones can follow [it could] be another kind of further-out-there application of this technology."

Layered over original LiDAR imagery, Ushr roadway data includes details like cross-slope, lane width, lane markings, and more, all globally geo-referenced to sub-10 centimeter accuracy. Data is available every 0.5 meters along the road.
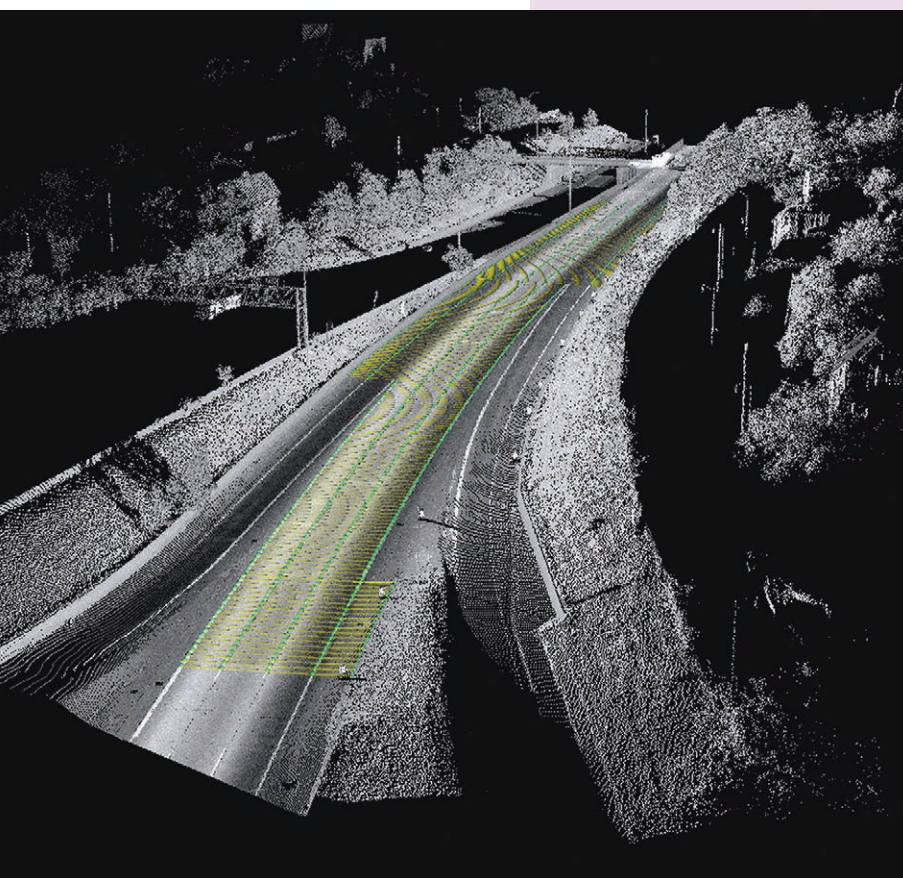
IMAGE COURTESY OF USHR

Bringing Eyes to the Skies—For Rent

Unmanned aerial vehicles, more commonly known as drones, are one of the most public symbols of GEOINT's new era. But many companies that could benefit from the ability of drones to extend human senses to places that are difficult or dangerous for humans to reach lack the budget and expertise to buy their own systems.

That's where D.C.-based Measure comes in, offering drones and analytical tools clients can hire for particular jobs. This business model—what it calls "Drones as a Service"—has given the firm extensive insight into what drones can and cannot do.

"Agricultural is probably one of the most overhyped applications for drones," cautioned Abigail Lacy, Measure's vice president of sales. "Anybody you talk to who's been in the drone space for more than two years would probably tell you that."

A drone's different perspective can, however, make a difference at the margins by gathering data points about exactly where in the field a crop is flourishing or struggling.

"A lot of them really derive from just having the eye in the sky—not just the RGB, but the NDVI," Lacy said, referring to the Red-Green-Blue of traditional imagery and the Normalized Difference Vegetation Index that a near-infrared camera can produce to indicate the presence of live vegetation.

That, in turn, can allow for a more precise, cheaper application of fertilizer.

But many farmers remain skeptical. "They just tend to be slow adopters when it comes to technology," she continued. "They're really hesitant to drop money on all of this different equipment."

Measure is more bullish about the potential for drones to provide insight for industries such as construction and energy. Lacy cited solar farms as one example, touting the ability of drones to answer questions before construction, such as: "How productive will the solar farm be?" and "Am I going to have water runoff issues on the site?" Once the site is in operation, drones can help identify malfunctioning panels.

Measure doesn't disclose its rates, but Lacy cited internal research that the company's service can yield $7,200 in annual savings on a 10-megawatt solar facility compared to traditional inspections.

She noted drones don't just operate at a lower cost than manned aircraft, they can also get lower to the ground. The firm relies mostly on visual and thermal cameras.

"We are keeping a close eye on how LiDAR is evolving," she said, but added that so far costs are too high and quality is too low.

The firm also often has to deal with a lesser GEOINT hindrance—every company seems to have its own proprietary software. "You'll get 15 different software providers that all have a unique system," Lacy said.

Measure hopes automated data processing will cut down on its own overhead, but the real "game changer" would be automation of a drone's flight—which, in turn, will require a loosening of regulations that today ban drone flights beyond a human operator's visual line of sight.

Digital maps have supported more than **$1 trillion** of yearly sales for businesses.

Fusing Maps and Live Data

Now that so many mobile devices come equipped with GPS receivers—meaning the apps on those devices can also geo-tag user activities—coping with the massive scale of the resulting data becomes a challenge.

"As the variety of channels and devices that connect customers, companies, and physical assets increases, so too do the ways to measure and analyze spatial information," a 2016 Forrester report observed. "One of the great challenges for effectively making use of location data has been integrating it with other data sets and analysis to provide deeper context and insight."

That's a big theme in the work of MapD, a D.C.-based firm that's made a specialty out of integrating live data with maps.

One of its most fascinating demos tracks the last several weeks' worth of geo-tagged tweets around the world, placing them on the map and color-coding them by language. Users can search for keywords and hashtags or just float the cursor across countries to see what is trending. For example, the large rectangle hovering over Finland turns out to be *@EveryFinnishNo*, a bot that tweets out the Finnish word for a new number every minute.

Another MapD demo offers a similarly granular look at ship movements around the U.S. from 2009 to 2015, both offshore and in lakes and rivers. "Tug" is overwhelmingly the most popular type of vessel, with more than five billion records.

A third demo provides a look at nearly seven years' worth of taxi rides across New York City, from 2009 to 2015. During that time, cash transactions outnumbered credit, at more than 632.1 million cash transactions versus more than 510.8 million credit—while more than 2.2 million rides were recorded as going uncharged.

MapD's New York City taxi ride data set currently totals approximately 1.2 billion records.

The massive computational power provided by GPUs is critical to these efforts.

"GPU computing is really going to take data to the next level and analytics to the next level," said Monica McEwen, MapD's vice president for U.S. federal customers. She pointed to how this revolution in processing power allowed Verizon Wireless to accelerate its analysis of network problems.

"Historically, they had to do that in batch mode," she said. "Today, they're looking at that in real-time."

Also important: Ensuring interfaces scale up to meet a density of data she predicted will mean "being able to display literally billions of records and have a response time in the milliseconds."

"The pure volume of [data] makes it nearly impossible to present it in a fashion in which people can make meaningful sense of it," McEwen said. As a result, MapD's interfaces let users easily add or remove layers of data so they can focus on particular variables.

Strava's Global Heatmap of New York City reveals popular routes and activities.

Crowdsourcing Exercise Intelligence

Strava, a workout-tracking app popular with many cyclists and runners, has a different challenge to address. Mashing up the location reports it gets from users can inform individual Strava athletes looking to find popular routes on its heatmap.

That trove of data soon caught the attention of urban planners, and that led to a complementary product: a database of cycling and pedestrian activity over time called Strava Metro.

"We started hearing from departments of transportation who said, 'This is cool, but we can't see the temporal details,'" said Brian Devaney, sales and marketing lead for Strava Metro. "We had to figure out a way to get all those GPS pulse points and aggregate them and anonymize them."

Combining the heatmap with Metro required the firm to address privacy risks.

Part of its answer is privacy options. Users can choose to place a geo-fence around a home, office, or other location, hiding it and the last 500 meters of a route from the view of others. A more comprehensive enhanced privacy option suppresses even more data from the feeds of other Strava users, down to your last name.

The company won't say how many users have exercised either option, but many customers never touch the default settings. To keep their information safe as well, Strava aggregates individual GPS measurements without reference to where users started and ended their workouts. The result is an alternative map in which a major highway like Interstate 66 in northern Virginia vanishes from view, while the bike trail next to it glows yellow but leaves no hint of where along the path one person started or ended their ride or run. Strava's underlying maps, developed by D.C.-based Mapbox on top of cartography from OpenStreetMap, automatically show bike- and pedestrian-hostile roads in gray.

Even in small towns like rural Lincoln, Va., enough users walk, run, or bike to leave a dense web of trails on Strava's heatmap. To use this to get a sense of an individual's whereabouts, you'd need to know where they live first.

Strava Metro, launched in 2014, offers customers not just the heatmap's static view (updated once a quarter) of overall movements but also minute-by-minute data about how many people went in one direction on one street. Again, the company boils its data down to GPS points, this time showing direction and time, while removing everything else.

"We do buffer for privacy," Devaney said of the company's decision to obscure the start and end of a workout route.

And users can opt out of having their data used in Metro at all, although only "a fraction of a percent" have done so.

Customers such as city and state transportation departments as well as cyclist advocacy organizations use this data to plan or push for improvements such as bike lanes and wider sidewalks, then audit how the new infrastructure performs.

They can learn what corridors are most busy during peak commute times versus on weekends," Devaney said. "A lot of groups are using the data to understand how behavior changes after they put in infrastructure."

You can imagine that this data would also be enormously attractive to such businesses as athletic-wear manufacturers, but Strava has chosen to limit its sales of Metro data to organizations "working to influence policy and infrastructure."

Eschewing commercial use of data gathered from workout-tracking apps happens to line up with one of the core privacy principles put forth last year by the Future of Privacy Forum.

WHAT'S NEXT? MEGACITIES, DRONES, AND SMALL SATS

In terms of its commercial evolution, GEOINT is barely old enough to run for office. What could it look like by the time this roughly 25-year-old discipline is old enough to run for president?

USC's Fleming said a larger trend—humanity's move to large cities, in which the height and volume of buildings make the traditional references of GPS unusable or suspect—will force a switch to more resilient location technologies that work better inside and next to large structures.

"We're piling up people along the coastlines of the world, so we have to deal with megacities better."

Many smartphone users have already seen this problem when location-based apps lose a GPS signal, decide a nearby WiFi router that happens to have been moved from one venue to another is just as valid, and vault the user to a spot miles away.

Fleming also expects drones to become even more on-demand, "where everyone expects them to be around and they're providing things like public safety services."

But a world in which the whine of quadcopter rotors is a normal part of the background din may take some persuasion by drone vendors.

Fleming's colleague Andrew Marx pointed to a different form of GEOINT system: small sats.

"The advantage of a small sat is you can build up an activity of an object," Marx said. "You can have so many repeat observations."

But adding this temporal dimension to GEOINT will require further innovation to display it. The tasks MapD and Strava already face will only grow more arduous.

"It's a struggle, because we're trying to depict things in four dimensions," Marx said.

Penn State's Bacastow, meanwhile, warned about two trends people might not appreciate as much.

One is which countries are focusing their efforts in this area. "Many of our students in AI and deep learning are not from the U.S.," he said, referring to a recent presentation by the University of Missouri's Dr. Curt Davis. "Counting publications, you'd find that scholars from other countries, such as China, have a significantly larger number of publications than scholars from the U.S."

Another is how different generations view the privacy implications of having their geo-location harvested by smartphone apps. Bacastow recounted a freshman seminar he taught two years ago about geospatial privacy.

"I thought students would be concerned and engaged in a seminar about their loss of privacy," he said. "Quite honestly, they didn't care. For them, while they understand the loss of their location privacy, as one student put it, 'I want my pizza delivered to the right place with the push of a button.'" 🌐

radiant
SOLUTIONS

REVEALING INSIGHTS

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Object Detection	Count
Aircraft	85

FOR MORE THAN 33 YEARS spanning more than 7,000 episodes, Alex Trebek has been host of the popular TV game show *Jeopardy!* During that time, the erudite emcee has seen it all. He's watched geniuses crash and burn. He's seen people win—and lose—millions. Perhaps the most remarkable *Jeopardy!* event of which Trebek has been a part, however, was the match wherein *Jeopardy!* champions Ken Jennings and Brad Rutter challenged Watson, an IBM supercomputer.

the algorithm *age*

Watson had been trained to answer trivia questions using a combination of data mining, pattern recognition, and natural language processing. During the course of three televised matches that aired in February 2011, Watson destroyed its human challengers, winning $77,147 compared to Jennings' $24,000 and Rutter's $21,600.

"I didn't give it the kind of serious thought I should have in terms of examining the technology required to have a computer that will understand the nuances and subtitles we present with our clues in *Jeopardy!*," Trebek told *TIME* magazine. "It wasn't until I saw the computer play that I thought, 'Holy smokes, this is serious stuff.'"

When it was first developed in 2007, Watson took two hours to answer a single *Jeopardy!* question and struggled to beat even child competitors. That it could trounce adult champions a mere four years later is a testament to the power of artificial intelligence (AI) and machine learning. AI and machine learning have matured even further in the seven years since Watson's victory, graduating from novelty to necessity—especially for the defense and intelligence communities, which are simultaneously researching and operationalizing machine learning in order to win an entirely different kind of competition: what some senior military officials are calling an "AI arms race."

THE CASE FOR COGNITIVE COMPUTING

So-called "deep learning" is the machine learning technique that most interests the defense and intelligence communities. Although the computer science behind it is complex, its premise is simple: A computer receives a question and identifies an array of possible answers. To determine which answer is correct, it uses hundreds of algorithms to examine the available evidence, including what type of information is available and how reliable it is. Using neural networks that simulate human brain function, each piece of evidence is weighted against the rest. Ultimately, the

In the defense and intelligence communities, machine learning has graduated from nascent to operational

BY MATT ALDERTON

computer ranks the possible answers from most to least likely and puts forth the most promising one. Human operators subsequently tell the computer whether it was right or wrong, at which point it self-edits its algorithms. Each time the computer answers a question it "learns" something new, which over time allows it to reach more accurate and reliable conclusions.

This capability is especially attractive to the U.S. Department of Defense (DoD) as it pursues what it calls the "Third Offset."

Consider, for example, the U.S. Air Force. "We look at neural networks like they're wingmen," said Capt. Michael Kanaan, director's action officer for U.S. Air Force Intelligence (AF-A2), which envisions a future where U.S. airmen are assisted by machine sidekicks that constantly analyze the world around them, à la *Star Wars'* R2-D2. "We're training our R2-D2 to be right there with us. In that way, machine learning acts as a decision aid. It can shrink the time radius of our OODA loops: observe, orient, decide, and act."

Simply put: The increased speed and certainty it can gain from machine learning will allow the U.S. to remain ahead of its adversaries. "AI and machine learning provide us insight at speed and scale that we otherwise would not have," Kanaan continued. "It has second-, third-, and fourth-order effects that create decision advantage for us."

There are practical benefits as well as strategic ones.

"One of the main challenges [the Intelligence Community (IC) faces] is data volume," said Central Intelligence Agency (CIA) spokesperson Jonathan Liu. "For example, thousands of terrorist videos are uploaded on a daily basis. Therefore, there is a need to detect, characterize, and triage data in a scalable manner. Machine learning enables and assists our officers to maximize their time in solving problems and making high-level decisions."

Data-processing fatigue is another important challenge machine learning can help solve. "For example, it is known that human visual recognition performance decays with time. In contrast, well-trained algorithms can sustain constant performance and process data 24/7," Liu said. "Combining both human and machine-driven decision-making is the optimal way to solve problems. Specifically, using machines to automatically solve basic, repetitive, and time-consuming tasks, such as finding small objects in image collections. The summarized data then serve as the initial pre-culled data set needed to solve highly complex intelligence problems."

In other words, machine learning makes a force multiplier of computers, achieving maximal analytic capacity with minimal human resources.

IC ADVANCES

AI's benefits have been apparent for decades. As the technology advances, the IC is moving quickly to test and field new machine learning capabilities.

The CIA has approximately 140 pilot projects underway, with the goal to transfer machine learning from researchers and data scientists to customers and operators.

"The range of applications varies widely and applies to most of CIA's components. Data understanding is an overarching objective, including the extraction of patterns impossible to find with standard or traditional manual techniques. Examples include change detection across different timeframes, and amplifying imperceptible motion patterns from pixels," Liu reported.

Multimedia analytics is an area of emphasis, according to Liu: "This includes natural language processing tasks such as automatic machine translation and transcription, and image and video processing tasks such as object and activity characterization."

The Intelligence Advanced Research Projects Activity (IARPA) is working on numerous programs designed to deliver machine learning capabilities to the IC, according to IARPA Program Manager Hakjae Kim.

The program about which Kim is most enthusiastic is the Functional Map of the World (fMoW) Challenge, which concluded in December and in February will award cash prizes to the top five participants who developed algorithms to detect and categorize buildings, structures, and land uses in satellite imagery—a challenging task due to the sometimes low resolution and high variability (e.g., time of day, weather, etc.) of satellite images. To help participants train their algorithms, IARPA published one of the largest-ever publicly available satellite image datasets, annotated with more than a million points of interest across approximately 60 categories such as hospitals, schools, lighthouses, bridges, and cellphone towers.

"We've invested a lot of money to create inputs and outputs that can be used to train deep neural nets," explained Kim, who hopes the algorithms produced during the fMoW Challenge will activate a community of developers who continue to apply their expertise toward IC objectives. "As more people become familiar with IC challenges, they'll be able to use [the dataset we created] to help us solve our problems, which will be a bigger contribution than the algorithms that come out of the competition."

Like IARPA, NGA is leveraging external expertise to acquire and scale its machine learning capabilities—most notably through its Global Enhanced GEOINT Delivery (Global-EGD) contract with DigitalGlobe, whose Geospatial Big Data Analytics (GBDX) platform is a marketplace through which customers can acquire machine learning algorithms created by DigitalGlobe and third-party developers for use with DigitalGlobe imagery.

"The Global-EGD contract's largest and most attractive asset is the EnhancedView Web Hosting Service, which provides near-real-time access to over 1 billion square kilometers of DigitalGlobe imagery," explained NGA Program Manager Brian Bates. "We've worked very closely with DigitalGlobe to build an interface between the Enhanced-View Web Hosting Service and GBDX so our analysts can access ... algorithms to run over different areas of interest that correspond with their mission set."

An acquisition, design, delivery, and demonstration activity completed in summer 2017 unearthed a number of algorithms NGA analysts are currently applying across missions, according to Bates. There's a water detection algorithm, for example, to identify water inundation after

> "Machine learning is going to help tell the analysts where to look. If you're looking for a white truck, why spend time looking at hours of video where there's no white truck? Let's just give the analysts the video where the white truck is."
>
> —KEVIN BERCE, BUSINESS DEVELOPMENT MANAGER, NVIDIA

natural disasters; a soil detection algorithm to identify construction activity; and ship and plane detection algorithms to detect unusual air and marine activity. As of November, NGA is using a material identification algorithm that can detect manmade paints and polymers and a vehicle detection algorithm that can identify cars and trucks, as well as distinguish between them.

"[Analysts] receive alerts in the interface as well as email alerts … indicating that the threshold they have set for activity or number of objects has been met or exceeded, and what area that happened in," Bates said. "Eyes-on-imagery analysis is a time-consuming process, and if you're doing missions like search or monitoring it can be extremely tedious."

DEEP LEARNING AT DoD

The DoD is pursuing machine learning capabilities as enthusiastically as the IC. The Army Research Lab (ARL), for example, is exploring a number of ways to enable deep learning at the tactical edge.

"This kind of computing is going to be embedded wherever we do computing," said Dr. Brian Sadler, Army senior scientist for intelligent systems at ARL. "It's going to be lightweight and low-power, and that's going to allow us to apply algorithms not just in robots, but on sensors."

On sensors, machine learning eventually will exploit "cognitive radio" techniques to create self-forming and self-healing networks. Such techniques allow warfighters and sensors to intelligently manage spectrum usage and network capacity in contested environments where wireless communications face hacking, jamming, and spectrum scarcity. Many of these challenges can be mitigated by machine learning algorithms that support dynamic changes to signal structure and frequencies, allowing data to be shared freely and securely as the environment evolves.

Watson is also helping the Army push machine learning to the tactical edge, according to IBM. Instead of competing on game shows, Watson is helping the Army's Logistics Support Activity leverage the Internet of Things (IoT) to predict vehicle maintenance failures across the service's fleet of 3,500 Stryker combat vehicles.

"The Stryker has the same [IoT] computer system that we all have in our cars," said Sam Gordy, general manager of IBM's federal business. "Merging that structured engine data with unstructured data like training manuals, field manuals, and handwritten maintenance reports from the field, then laying predictive analytics on top of that, allows us to, in essence, deliver personalized medicine to each individual Stryker combat vehicle. That not only gives you return on investment—lower maintenance costs—but more importantly gives you return on mission in the form of equipment uptime so you're not putting soldiers at risk in the field."

As it ingests more maintenance data from more vehicles, Watson will become smart enough to predict which vehicles will fail, as well as how, when, and under what circumstances.

As powerful as these predictive analytics are, machine learning's greatest promise doesn't lie in IoT insights, but in computer vision, which is the focus of DoD's signature machine learning operation: Project Maven.

Established in April 2017 by Deputy Defense Secretary Robert O. Work, Project Maven—otherwise known as the

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USGIF WORKING GROUP TACKLES MACHINE LEARNING CHALLENGES, OPPORTUNITIES

USGIF established its Machine Learning & Artificial Intelligence Working Group in March 2017.

Co-chaired by Michael Rampino, principal at RMA Consulting; Kevin Berce, business development manager at NVIDIA; and Ted Josue, director of intelligent systems and machine learning research at Riverside Research, its charter is to build a community of interest by focusing on:

> Near-term hard problems of interest to the GEOINT Community that might be addressed by machine learning and AI technologies and methods.

> Current and emerging machine learning and AI capabilities that have yet to find wide adoption in the community or application to problems of interest.

> Improving the productivity of analysts and decision-makers, and finding more efficient and effective ways to keep up with the growing amount of data to be processed and analyzed.

> Identifying and addressing the effects of machine learning and AI to community workforce training and development needs.

To advance its objectives, the working group meets monthly, has established several sub-working groups dedicated to defining and solving specific machine learning challenges, and in November hosted USGIF's second Machine Learning & Artificial Intelligence Workshop.


Algorithmic Warfare Cross-Functional Team—is led by Air Force Lt. Gen. John N.T. "Jack" Shanahan, director for defense intelligence for warfighter support with the Office of the Under Secretary of Defense for Intelligence. Project Maven's goal, according to the memo that established it, is "to turn the enormous volume of data available to DoD into actionable intelligence and insights at speed." Step one toward achieving that objective is augmenting or automating processing, exploitation, and dissemination (PED) of full-motion video (FMV) captured by unmanned aerial vehicles in support of DoD's campaign to defeat ISIS.

At press time, Shanahan's 12-person team was on track to achieve the following goals by the end of calendar year 2017: organizing a data-labeling effort; developing, acquiring, and/or modifying algorithms to accomplish object detection, classification, and alerts for FMV PED; identifying required computational resources; determining a path to

MACHINE LEARNING SYSTEM

CAT
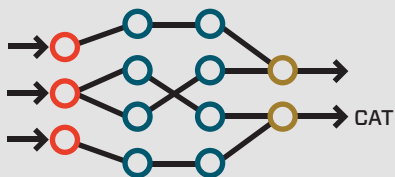
THIS IS A CAT.

CURRENT AI EXPLANATION

THIS IS A CAT:
> IT HAS FUR, WHISKERS, AND CLAWS
> IT HAS THIS FEATURE

XAI EXPLANATION

IMAGE COURTESY OF DARPA

DARPA's Explainable AI program aims to create a suite of machine learning techniques that produce more explainable models, enabling human users to understand and trust the emerging generation of artificially intelligent partners.

fielding necessary infrastructure; and integrating algorithmic-based technology with programs of record.

As promised by Shanahan, Project Maven's first algorithms were delivered in December for testing.

"DoD has a huge influx of video coming in. Inside all this video are nuggets of intelligence, but there's too much of it for analysts to ingest and digest to then make an intelligence decision on," said Kevin Berce, business development manager at NVIDIA and co-chair of USGIF's Machine Learning & Artificial Intelligence Working Group. "Machine learning is going to help tell the analysts where to look. If you're looking for a white truck, why spend time looking at hours of video where there's no white truck? Let's just give the analysts the video where the white truck is."

MAN VS. MACHINE

Project Maven is expected to be a playbook for acquiring and operationalizing machine learning capabilities across DoD and the IC. One of the most valuable lessons it has yielded so far is that human analysts remain essential, according to Kanaan.

"Our approach is the idea of human-machine teaming," explained Kanaan, who said the ultimate goal is for machines to take over the "observe" and "orient" components of a typical OODA loop so human analysts can concentrate on the "decide" and "action" components.

Although the goal is for humans to eventually rely on machines, for now it's machines that must rely on humans, according to Kanaan, who stressed labeling as a key component of Project Maven; so far, he said, more than 1,000 Air Force intelligence analysts have labeled "tens of thousands" of objects for use in training Maven's algorithms.

Data labeling is only the first step. Next must come data validation, which is a major priority for NGA, according to Bates. "We will be instituting a feedback mechanism where the analyst can click on the image and tell the algorithm where it failed," he said. "That information will then go back to the algorithm developers to help them retrain their algorithm."

Currently, Bates said, the algorithms NGA acquired from GBDX have an accuracy rate of approximately 70 percent. "That's pretty good," he continued, "but for government work we need it to be a lot more authoritative than that."

That cooperation hinges on trust, according to Bates, who cited user confidence as a major hurdle. "[It's the] crawl-walk-run paradigm," he said. "Right now we're crawling. And the reason I say that is because you can run algorithms against imagery all day long, but you're not going to gain any kind of authority or trust with the elements if analysts don't have the ability to verify the accuracy of those algorithms."

The Defense Advanced Research Projects Agency (DARPA) is working on a solution: what it calls "Explainable AI."

"These very complex data analysis algorithms are giving recommendations to an intel analyst, but the analyst may not understand why the system is making that recommendation," said David Gunning, a program manager in DARPA's Information Innovation Office. "That analyst gets judged according to the quality and accuracy of her recommendations, so in order to feel comfortable putting her name on the recommendation that goes forward she wants to understand what the machine learning model was thinking."

Enter Explainable AI, which launched in August 2016 under Gunning's tutelage. The five-year program has awarded contracts to 11 teams that are building software prototypes capable of explaining machine learning outcomes to human users. Like students in a high school math class, each team's system will be instructed to "show its work."

"Users will be able to ask the system, 'Why do you think that's a convoy in North Korea?' And the system will come back with an initial explanation like, 'Oh, I think these are trucks and they've all been on the road for an hour,'" explained Gunning, who said explanations might be verbal or visual (e.g., a photo with items circled on it). Understanding a system's logic will build fidelity in a way that increases machine learning's adoption across government. It's not just about adoption, however. Because future adversaries might be able to hack American algorithms, it's also about security, according to Gunning, who cited research wherein users were invited to use two different machine learning systems running the exact same algorithm.

"Experiments have shown that ... if you just put a smiley face on one of the systems, people will trust that system more than the other one," Gunning said. "So, it's easy to fool people [when they can't see] if the system is making a mistake or not."

And machines do, in fact, make mistakes—just like humans. Which is why the future of data analytics isn't man or machine; it's man and machine. The question facing the defense and intelligence communities now is when and how the two can work together most effectively.

"Our workforce is ready for this. They deserve an unleashing of their innovative culture, and largely what underpins that innovative culture is the tactics in which you use technology," Kanaan concluded. "While the nature of war remains largely unchanged, the character behind it is defined by those who can most quickly and effectively adapt in response to new and disruptive technologies." 🌐

This Harris Geiger-mode LiDAR shot was captured over the city of Chicago.
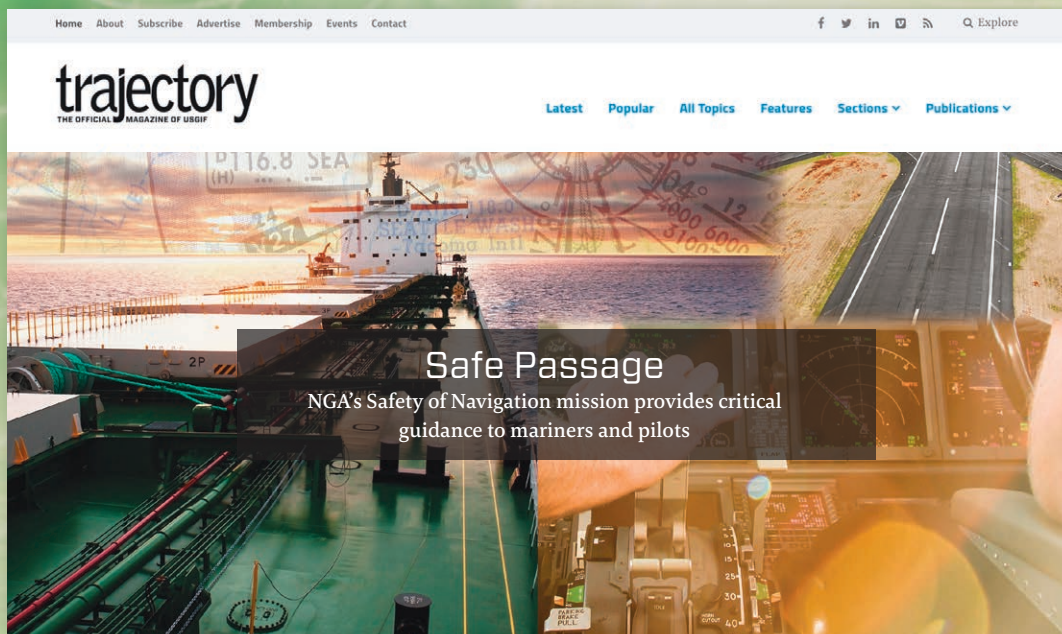
IMAGE COURTESY OF HARRIS

Harris Corporation: Enabling the End User
Erik Arvesen, vice president and general manager, Geospatial Solutions

Q What products and services does Harris offer the GEOINT Community?

We work with myriad customers and mission sets ranging from defense commands and civil government to utility companies and commercial business. Each of those has very different challenges. After assessing the specific needs of a customer, we apply our diverse tools and services. We offer everything from real-time onboard data processing for airborne sensors to ground processing systems. We have advanced off-the-shelf software like ENVI, which extracts actionable information from remote sensing data through change detection. We use Geiger-mode LiDAR sensors for applications from the U.S. Geological Survey to utility companies looking at transmission lines. We also have different machine learning and video analysis capabilities.

Q How would you describe your company culture?

The passion our teams and individuals have for our customers' missions is intoxicating and resonates throughout our facilities in Colorado, Los Angeles, Florida, St. Louis, Rochester, N.Y., and the D.C. area. Additionally, the company's heritage is based on cutting-edge technology. The ENVI software team and the company's Visual Information Systems, for example, have technology-centric mindsets. All this goes back to understanding the customer's specific challenges and how we can use innovative technology to solve their problems.

Q How has Harris evolved to keep pace with the explosion of geospatial technology in the last decade?

Having competence and comfort in solving complex problems using multiple data sources is a big part of

Erik Arvesen

our core capability and has been for a long time. The explosion of geospatial data tees up the marketplace and the commercial landscape into our sweet spot. We deal well with highly complex situations. The more complicated the problem is, the more intriguing it is for our teams. To deal with that complexity, we employ deep learning tools to specific imagery sets, going well beyond simple object detection.

Q What sets Harris apart from its competition?

It's a combination of experience and investment in the future. We have more than 30 years of experience developing geospatial solutions using cutting-edge technology, so organizations seek our in-depth knowledge. Many of our analytic solutions are applicable from one customer mission to another. I'm a firm believer in this mindset of looking through the end customer's lens first and backing into a solution that best fits their needs. Additionally, we're investing quite a bit of internal research and development dollars in deep learning, artificial intelligence, and hardware for LiDAR.

Q What emerging GEOINT trends is Harris most excited about and how are you leveraging them to support your mission?

We're seeing an emphasis on the use of commercial and open-source GEOINT data, products, and services. I've spoken with several strategy leaders at the National Geospatial-Intelligence Agency (NGA)—they definitely want and need to move toward commercial open source. That resonates with our strategy.

Similarly, there's an emphasis on small sat capabilities. This new paradigm of imaging the entire Earth every day means oceans of data are flooding in. In turn, that data intake requires more automation and machine learning. Having those capabilities allows us to continue managing the data coming in from our partners, like Planet and DigitalGlobe.

Also, new cloud platforms like Earth on AWS and DigitalGlobe's GBDX are exciting for our engineers. It's all phenomenal technology, but the real fun for Harris is understanding the customer's needs and figuring out how to employ the tools we've spent a lot of time and money on to solve the challenges at hand.

Deloitte Consulting: Multi-Faceted Partnerships
Craig White, principal

Q Who are Deloitte's core geospatial customers and what services do you offer them?

The firm's engagement in the geospatial space is concentrated in two areas. One is NGA. We started our work with the agency almost 20 years ago supporting financial management operations, but that's just a fraction of our business today. Now we provide a number of additional services such as portfolio management, cloud strategy, cyber risk analysis, customer segmentation, big data analytics, and process automation—to name a few. Additionally, we now provide full lifecycle human capital services to NGA's Human Development Directorate, which is very exciting. Today we work with pretty much all of the NGA directorates, which we are very proud of.

The other area of geospatial support is the commercial side of our business, directly helping vendors and clients leverage geospatial data in a way that fits their method of operations. Data is very powerful, especially when you look at, for example, a major retailer's operations where we helped investigate how geospatial trends might trigger buyer behavior.

Q Do you have any tips or tricks to share about working effectively with government?

It seems pretty basic, but it starts with listening and understanding what your client's needs are. That's a step some in the business may miss. At Deloitte, we think hard about the client's problem, listen to what they are up against, and try to bring the full power of Deloitte against those particular challenges. When working with the government—or any client in any industry—consider how to bring the appropriate solutions to them based on their specific challenges or obstacles.

Q What are some geospatial projects Deloitte currently supports?

We're doing some pretty interesting work around cyber reconnaissance and supply chain illumination that we're excited about. Our teams are using open-source information in both of those projects to provide fact-based insight to NGA to help them understand cyber threats and possible vulnerabilities in their supply chain. We are also off-and-running on a project to help the agency realize its vision of automating regimented processes.

Q What differentiates Deloitte from other advisory firms?

We are the largest consultancy in the world. This isn't important because bigger is better, it's important because we can look at the global, commercial challenges we've helped clients deal with, and help our federal clients apply those best practices in an appropriate way. We believe that makes us unique.

One example is helping NGA realize its vision for automation. We've been able to take automation capabilities applied in the commercial space and tune them to the federal market to begin application at NGA. Our focus at NGA is helping take rudimentary, rule-based activities out of the hands of overworked individuals and automating them to free people up to focus on more complex challenges.

Q What are some GEOINT trends you're witnessing and how will those trends impact the community in the future?

The first that comes to mind is the

Juli MacDonald, senior manager, Deloitte Consulting, discusses process robotics solutions with an attendee at a Venture Café event in St. Louis.

PHOTO COURTESY OF ROMONDO DAVIS, VENTURE CAFÉ

challenge around human capital. We are directly engaged with NGA in this area. As the agency continues to pivot its style of operations, it is faced with the challenge of helping the current workforce transition their skills and capabilities to serve that future operating model. We've also done some interesting work to strengthen their talent acquisition methods. We are working in collaboration with a St. Louis-based nonprofit called Launch-Code to provide technology job-seekers with accessible training, paid apprenticeship, and then job placement. That's the sort of innovative solution NGA will need going forward.

Another top-of-mind trend we are seeing is the use of advanced analytics to inform decision-making in all aspects of operations. The challenge is to take a vast amount of data, use it to support tactical decision-making, and then pivot to support the broader strategic actions the agency needs to take. As NGA continues to harness advanced analytics and other technologies it will improve efficiency, effectiveness, and innovation. This is critical because the geospatial marketplace will continue to evolve at an ever-quickening pace.

Individual Member Spotlight: Find Your Passion
Andrea Keilholtz, vice president, Whiteboard Federal

Andrea Keilholtz

Andrea Keilholtz has spent just more than a year as vice president of Whiteboard Federal, an analytic and software engineering firm focused on data science and cloud technology. After graduating from California Polytechnic State University, San Luis Obispo, she found work supporting an Intelligence Community (IC) map library, where she helped manage the transition from hard copy maps to digital data as well as the creation of geospatial repositories. With

nearly 30 years of experience in the geospatial field, she has gained expertise in geospatial engineering, project management, systems engineering, business development, government contracts, and more.

Q What is your advice for young, aspiring GEOINT professionals?
Find your passion. See if you can turn it into a viable opportunity. I went to college for landscape architecture. In my third year of design, we were introduced to GIS technology and I absolutely fell in love with it. Because my parents were in the IC, I spent 13 years living overseas. That experience developed my interest in geography, people, and cultures, and that integrated well with GIS.

My career was always about supporting the mission. Creating, searching, and retrieving geospatial data and creating actionable intelligence to support the mission was my way of contributing to the GEOINT discipline. Every day held a new challenge. Think about what aspect of the discipline related to geospatial science or intelligence is attractive to you, follow that, and see where it can lead.

Q How do you keep your team on pace with the industry's constantly evolving IT and data needs?
Whiteboard Federal is great about providing training to individual employees. We have a lot of self-motivated people that train on their own through reading and online classes. We also have a significant annual training budget allocated to every single employee in the company, along with an additional 40 hours of chargeable training time. A huge percentage of this company takes advantage of that.

In addition, we have a bounty program for technical certification. We offer employees between $500 to $1,000 to obtain certifications in topics that are in high demand or are required for specific contracts. Quite a few of our people pursued certifications in 2017, so we'll run the statistics and hopefully that will motivate even more people to do so next year.

Q What have you learned about being an effective, motivational leader?
The most important attribute is to listen. Listening applies to everyone: your employees, customers, and management. I place a great deal of value on people—your employees are your most valuable resource. I've had lots of employees follow me from one company to another and I take that as a compliment. Keeping employees happy and resolving issues immediately leads to a positive work environment.

### Q What excites you most about the future of GEOINT?
In the last several years, the latest "big thing" is cloud technology. Really, that is just a mechanism for dissemination and storage of all the data we have managed to acquire or produce. As we've come to terms with moving our data to the cloud, I feel we are back at the point where the stall in geospatial technological development is about to end. Our attention is no longer diverted to solving the data management problem, so we can concentrate on exploring what fantastic new applications and analysis we can do with our data. I think we're back on the upward slope of this roller coaster—it's going to explode again.

Q How has USGIF membership helped your career?
I became involved with the Foundation in 2004, the first year of USGIF's existence, and have attended all but two GEOINT Symposia. I'm a longtime member of the USGIF Planning Committee and was also the co-chair for the Interagency Working Group.

I find immense value in the convergence of like-minded people with the same passions into a forum where we can discuss industry trends and figure out how to disseminate geospatial information. Through USGIF working groups, the planning committee that organizes forums and meetings throughout the year, and certainly the Symposium itself, I was given the opportunity to connect with senior people at major intelligence organizations. I stay in contact with all the friends I've made through the network, and who I would've never met without USGIF. ⊕

horizons
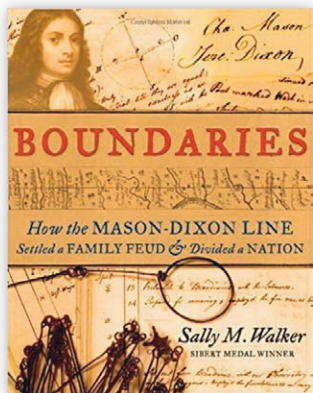
### Boundaries: How the Mason-Dixon Line Settled a Family Feud and Divided a Nation
By Sally Walker

This book tells the tale of the drawing of the Mason-Dixon surveyors line that divided North from South and represented America's universal right to liberty. The narrative weaves through the family feuds, scientific brilliance, and brave frontier exploration that resulted in the line's creation, as well as the underlying struggle to unify a polarized nation. This historic tale is supported with math, maps, and diagrams, and will inspire readers to question and explore the lines of demarcation in their lives.

The Geography of Genius: A Search for the World's Most Creative Places from Ancient Athens to Silicon Valley
By Eric Weiner

This *New York Times* bestseller examines the connection between humanity's most innovative ideas and the spatial surroundings of their creators. From Socrates' ancient home of Athens to Michelangelo's Renaissance Florence, this humorous travel guide walks the streets of creative ingenuity to explore how culture inspires genius.
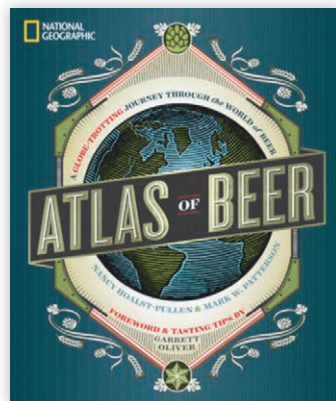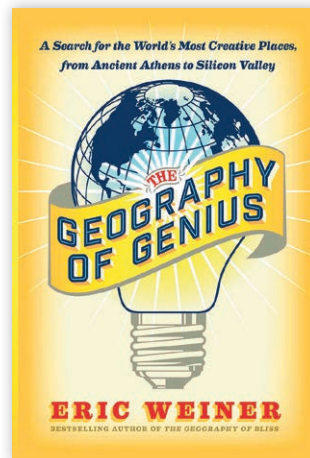
National Geographic's Atlas of Beer: A Globe-Trotting Journey Through the World of Beer
By Mark Patterson and Nancy Hoalst-Pullen

This book takes a deep dive into the art of craft brewing, capturing international beer history and trends through 100 detailed maps, 300 photos, tasting notes, trivia, and travel tips. Ale aficionados and novices alike can learn about drinking culture on six continents, the world's best breweries and festivals, and the sudsy future of beer.

MARCH 13
GEOINTeraction Tuesday
McLean, Va.

APRIL 22-25
GEOINT 2018
Tampa, Fla.

MAY 8
GEOINTeraction Tuesday
McLean, Va.

PEER INTEL

Maxar Technologies appointed **MIKE GREENLEY** group president of MDA, a Maxar Technology company. Greenley previously served as sector president of L-3 Wescam.

Altamira Technologies promoted **JONATHAN MONEYMAKER** to president. Moneymaker joined Altamira in 2014 as executive vice president and CSO.

UK Chief of Defence Staff **AIR CHIEF MARSHAL SIR STUART PEACH** was appointed the new NATO Chairman of the Military Committee, the Alliance's senior military office

position. Peach joined the Royal Air Force in 1977, commanding the UK's intervention in Libya and becoming first Commander of UK Joint Forces in 2011. He will succeed Czech **GENERAL PETR PAVEL** as Chairman in June 2018.

ANTHONY ROBBINS joined NVIDIA as vice president of the company's public sector practice. Robbins will lead NVIDIA's federal and defense businesses in the U.S. and Canada, and oversee its higher education and research businesses. Prior to NVIDIA, Robbins served as vice president of global defense at AT&T

and in various positions at Brocade, Oracle, Sun Microsystems, and Silicon Graphics.

Northrop Grumman named **KATHY WARDEN** its next president and COO following the retirement of current president and COO **GLORIA FATCH**. Additionally, corporate VP of government relations **SID ASHWORTH** will retire at the end of this year. **MARK CAYLOR** will become corporate VP and president for mission systems, **SHAWN PURVIS** will become corporate VP and president for enterprise services, and **LESLEY KALAN** will become corporate VP for government relations.

perspective

THE DEMOCRATIZATION OF ENTITY RESOLUTION

Q&A with Jeff Jonas, founder and CEO, Senzing

Prior to July 2016, acclaimed data scientist Jeff Jonas was an IBM fellow and the company's chief scientist of context computing. In August 2016, Jonas founded Senzing, a spin out of IBM focused on delivering entity resolution to the world at large. Jonas' work played a role in defeating card count teams as depicted in the book *Bringing Down the House* and the movie *21*. Jonas was briefly a quadriplegic in 1988 following a car accident. Since then, he has fully recovered to compete in more than 50 Ironman triathlons and is one of only four people to complete every Ironman triathlon in the world. Jonas is also a member of USGIF's Board of Directors.

Q Can you tell us about the decision to spin Senzing out of IBM?

I proposed a spinout to IBM, and we spun out a license for the source code, the rights to practice some patents, and some core team members. It has turned into a unique and fantastic partnership, and has allowed my team to get singularly focused on democratizing entity resolution (ER).

Q What is entity resolution?

Senzing's mission is ER—it's all we do. All organizations have duplicate identities in their data. On your phone you probably have duplicates. Imagine this problem for a bank, social service agency, or healthcare organization with tens or hundreds of thousands, or even millions, of identities to manage.

A marketing department trying to remove duplicates from their mailing list is the simplest use case. Most organizations purchase expensive and complicated ER products that are difficult to use and require experts. Or they try to perform ER themselves, which is even more challenging and requires a team of programmers. Our mission is to make world-class ER easy and affordable.

Our ER software, G2, helps organizations find non-obvious connections in their data. For a bank, are you looking at five customers each with one bank account or one customer with five bank accounts? ER is also ideal for insider threat detection, like finding the nexus between a former employee that was fired and an insider threat investigation.

Q How might ER be useful to the Intelligence Community?

Intelligence is often about keeping an eye out for bad guys, for example to make sure they're not coming into the country or showing up on the radar in some surprising way. Historic intelligence failures are often because the dots weren't connected fast enough.

You have to be able to do fuzzy matching to find clever criminals. As such, ER must take into account things like name misspellings, messy addresses, and number transpositions. It must see through all of this fuzziness to determine who's who.

Q What are the implications of ER for the GEOINT Community, more specifically?

ER allows data without a geographic location to be combined with data containing a geographic location. When such records resolve, data previously without location can be mapped.

Q What do you mean by the "democratization" of ER?

We are making ER easy to use, literally for the first time. As long as someone can use Microsoft Excel they can resolve entities. For example, if you buy a marketing file, how can you be sure you're not marketing to people who are already customers?

Or, one of our customers does supply chain risk assessment for global brands. They use ER to scrape lists looking for derogatory information about their vendors. ER allows them to go back to their customer and say, for example, "Do you realize your manufacturer is in trouble for three toxic spills and child labor? This could place your brand's reputation at risk."

Since 2012, an early version of G2 has been used by the Electronic Registration Information Center to modernize voter registration in America. As of December, one-third of the country runs on this system and both Democrats and Republicans love it.

Q Some experts say a global artificial intelligence (AI) "arms race" is beginning to unfold. What are your thoughts on this?

AI and machine learning (ML) have captured everybody's imagination. They are currently overhyped, but I still think it would be foolish to not make the most of them. AI will be a key differentiator for how people compete, whether banks competing with banks, governments competing with other governments, or law enforcement competing with organized crime. Regarding the notion of an arms race, I think technology has always been an arms race and this is just another flavor.

Q What's in store for the future of Senzing?

ER is a huge market and we're going to serve every corner of it. Our style of ML is unique and tailored to the kind of analytics required to conduct real-time ER. We have a long list of advanced features, though we are now focused on masking G2's sophistication to make it smart enough that it runs itself. 🌐

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