ON THE verge

WHERE IDEAS AND COLLABORATION FLOURISH

TEMPLE UNIVERSITY FOX SCHOOL OF BUSINESS

THE DATA SCIENCE ISSUE

on etsy, **SOCIALIZE FOR SALES** +

how **BIG DATA CAN COMBAT ADDICTION** +

what happens **IF WORK FOLLOWS YOU HOME?** +

MASSIVE AMOUNTS OF DATA ARE CREATED
EACH DAY.

WITH MORE DATA THAN EVER AVAILABLE
AT OUR FINGERTIPS, WE NEED HELP TO
MAKE SENSE OF IT ALL. THE FIELD OF DATA
SCIENCE UNITES RESEARCHERS ACROSS
DISCIPLINES, WHO EXTRACT KNOWLEDGE
FROM UNFATHOMABLE QUANTITIES OF
DATASETS. **DATA SCIENCE IS ENTERING A NEW
ERA, WHERE INFORMATION TECHNOLOGY IS
NOW CAPABLE OF SUPPORTING DATA-DRIVEN
BUSINESS IN REAL-TIME.**

WHETHER HELPING BUSINESS EXECUTIVES
MAKE DATA-DRIVEN DECISIONS,
ADVERTISERS TARGET LIKELY CUSTOMERS,
OR TEACHERS IDENTIFY KNOWLEDGE
GAPS IN STUDENTS, THE DATA SCIENTISTS
AT TEMPLE UNIVERSITY'S FOX SCHOOL OF
BUSINESS SORT THROUGH THE NOISE TO
DISCOVER GROUNDBREAKING INSIGHTS.

TABLE OF CONTENTS

HIGHLIGHTS IN DATA SCIENCE

1. FRESH FACES

Donald B. Rubin and Edoardo M. Airoldi join the Fox School's Department of Statistical Science, both from Harvard University. Don is one of the intellectual pillars of modern statistics. Over the past 40 years, his work has defined the discipline, with significant impact in government, industry, and academia, in areas ranging from economics and psychology to the health sciences. Edo brings significant knowledge in developing and applying statistical models to data in a variety of scientific disciplines, with specific interest in network data analysis and machine learning, as well as over $3 million in research grants to study topics such as how education and network capital affect upward mobility.

2. FORCE OF NATURE

Research from **Subhadeep Mukhopadhyay**, assistant professor of Statistical Science, and **Douglas Fletcher**, a doctoral student, may have impact on how artificial intelligence can learn and grow. They developed a statistical model for incorporating relevant expert-knowledge into objective datasets. Their work was recently published in *Scientific Reports*, a journal from *Nature Research*.

3. COLLABORATION ACROSS CAMPUS

Temple University's Data Science Institute acts as an umbrella for data science initiatives around campus. This includes work from colleagues like **Sudhir Kumar**, Carnell Professor of Biology, who leads a bioinformatics team that sifts through vast data banks of DNA and disease data to advance our understanding of evolutionary causes and origins of diseases and species.

4. BACK TO SCHOOL

The Data Science Institute welcomes **Yulia Vorotyntseva and Jeanne Ruane**, two new postdoctoral research assistants in data science and digital analytics for the 2018-2019 academic year. Yulia joins the Fox School from the University of Texas at Dallas, having received her PhD in Management Science, while Jeanne comes from Drexel University, where she earned her PhD in Educational Leadership and Learning Technologies.

5. SHOW ME THE MONEY

Through activities including the Young Scholars Interdisciplinary Forum, the PhD Student Research Competition, and Fox Research Seed Funding Program, the Fox School offers **over $100,000** in research support to Fox faculty and doctoral students each year.

INNOVATIONS IN DATA SCIENCE

a message from Dr. Paul A. Pavlou

How can we harness the power of data? By sifting through information to find meaningful patterns, researchers at the Fox School of Business and across Temple University are unlocking insights about our physical and digital worlds.

We are at the forefront of innovation in data science, a field that combines statistics, computer science, information systems, and business, to extract actionable knowledge from the vast quantities of data created every second. Across disciplines of management information systems, marketing, statistics, accounting, legal studies, and more, our data scientists are sorting immense data sets to discover groundbreaking insights. Using innovative technologies, advanced software, and invented algorithms, our researchers are united by a desire to understand the world around us.

The Fox School is also a proud leader of the Data Science Institute, which serves as the umbrella that unites research efforts across the university. The Institute brings together researchers from various disciplines to conduct research, engage industry in collaborative partnerships, and provide students with the research and professional skills to succeed in leading organizations. By fostering the natural synergies among these disciplines, the Data Science Institute amplifies the impact of research through increased interdisciplinary collaborations. Leveraging researchers' expertise—from the Fox School, College of Science and Technology, College of Public Health, School of Pharmacy, College of Engineering, and more—the Institute encourages researchers to seek opportunities, face challenges, and realize the untapped potential that exists in the deluge of information generated every day.

At the Fox School, our goal is to advance scientific inquiry, academic scholarship, and real-world impact. By harnessing the potential inherent in data to transform numerous areas of society, from business to healthcare to new technology, business executives can make data-driven decisions, advertisers can target more likely customers, and teachers can identify and fill knowledge gaps in students before it's too late—all thanks to the talented data scientists at Temple University.

DR. PAUL A. PAVLOU

Milton F. Stauffer Professor of Information Technology and Strategy

Senior Associate Dean of Research, Doctoral Programs, and Strategic Initiatives

Chief Research Officer
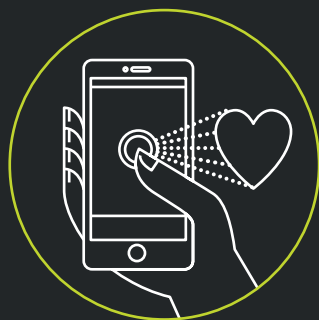
—
falling in love with
BIG DATA

BY SARAH DIOMANDE

To swipe or not to swipe?

Online dating has come a long way since the days of OKCupid in the early aughts. Today, phrases like "Tinder date" have become part of society's lexicon, and we have stopped buying a stranger a drink in a bar and started double tapping an Instagram photo from home.

What is different today? Instead of logging into a dating site on a computer, romance seekers now have mobile apps at their fingertips.

JaeHwuen Jung, assistant professor of Management Information Systems (MIS) at the Fox School of Business, investigated the changing business behind online dating to learn why companies are spending more money on developing mobile applications instead of web platforms.

With apps like Tinder and Bumble, data scientists have a trove of unbiased data from which they can extract insights. "We are able to trace the actions of both parties," says Jung. "We are able to see who is meeting who, what type of profiles they have, and [what] sort of messages they are exchanging." This provides a unique opportunity for researchers to analyze data untainted from other collection processes, like simulated experiments.

Jung says that dating is only one of many examples of how our phones have completely transformed the way in which we behave—and companies have caught on.

In his paper, "Love Unshackled: Identifying the Effect of Mobile App Adoption in Online Dating," which has been recently accepted for publication at *MIS Quarterly*, Jung used the online dating world to identify three drivers of why users, and subsequently companies, are moving from web to mobile: ubiquity, impulsiveness, and disinhibition.

UBIQUITY:
the capacity of being everywhere, especially at the same time

IMPULSIVENESS:
having the power to be swayed by emotional or involuntary impulses

DISINHIBITION:
a lack of restraint and disregard to social norms

With the ubiquity of smartphones, users are able to access mobile apps at any given time and location. Features like instant notifications, location sharing, and urgency factors, like Tinder's daily allowance of five 'Super Likes,' have allowed users to stay constantly connected.

"We use our mobiles in the most personal locations, like our beds and bathrooms," says Jung. For some, their phones may seem surgically attached to their hands.

With phones constantly by their sides, people more readily give in to their impulses, reacting to their moods or thoughts instinctively. Users can respond to such feelings—such as responding to a flirtatious message or liking a post—without a second thought.

"We found that [mobile platforms] change users' daily lifestyle patterns," says Jung. "Compared to those who use web platforms, mobile users have the luxury to log on earlier, later, and more frequently."

When a sense of privacy is assumed, users feel more anonymous on mobile—and are thus less likely to follow social norms. This disinhibition creates higher levels of engagement on mobile devices, Jung found, as users were more likely to engage in actions that they were less likely to do outside of the app.

"We saw that replies and views of [profiles of people with] different races, education levels, and even height, became more apparent through mobile apps," says Jung. "This has us questioning, can this [disinhibition] change viewpoints in real life?"

Like any business, owners try to keep customers coming back for more. These three key features—ubiquity, impulsiveness, and disinhibition—help companies keep users online every time they unlock their phones. With the convenience provided by apps, dating has become more successful for users and has benefited companies as well.

"If people leave happy," Jung says, "they will bring more new customers [to the app.]"

With the surge of app monetization, developers are able to make 55% of their mobile revenue through video ads, display ads, and native ads, according to *Business Insider*. Mobile apps have become a win-win situation as more people choose to scroll on the go.

Jung's paper is the first of its kind to examine the causal impact of companies' mobile channels in addition to their web presence. What can we say? All's fair in love, war, and big data.

CHANGING BEHAVIORS: HOW DISINHIBITION INCREASES PROFILE VIEWS

View profiles of users of a different race — Female: 56.5% Male: 67.4%
View profiles of users of short stature — Female: 47.2% Male: 71.6%
View a profile of users whose highest formal education level is high school or lower — Female: 104% Male: 113%

■ FEMALE USERS   ■ MALE USERS

#™
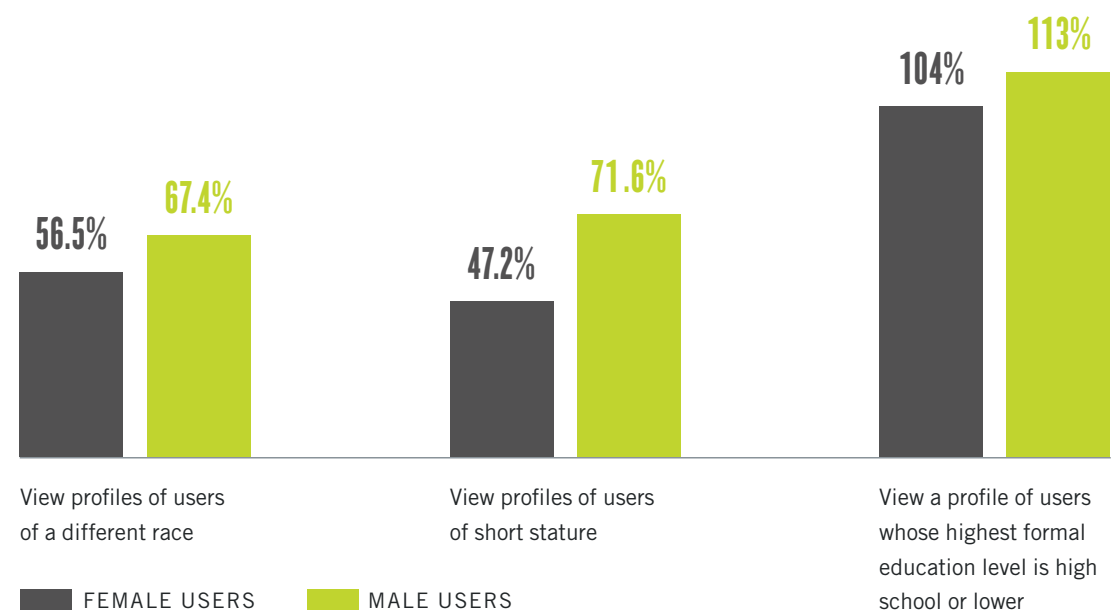
A HASHTAG WORTH A THOUSAND WORDS

BY MEGAN ALT

HOW MUCH IS A HASHTAG WORTH TO YOU?

THIS SIMPLE SYMBOL HAS BECOME UBIQUITOUS ACROSS MANY SOCIAL MEDIA PLATFORMS. STARTED IN AUGUST 2007, THE HASHTAG, ALSO KNOWN AS THE POUND (#) SIGN, WAS OFFICIALLY ADOPTED BY TWITTER IN 2009 AS A WAY TO GROUP CONVERSATIONS AND AGGREGATE SIMILAR THEMES. NOW, HAVING SPREAD TO SITES LIKE INSTAGRAM, FACEBOOK, LINKEDIN, AND PINTEREST, THE HASHTAG HAS BECOME A KEY ELEMENT OF MANY COMPANIES' SOCIAL MEDIA STRATEGIES. WITH THAT PERVASIVENESS COMES POWER—AND PITFALLS.

"Creating an original hashtag gives a firm control over a specific social media space," says Subodha Kumar, professor of Marketing and Supply Chain Management at the Fox School. Businesses can use this tool to increase recognition of their brand, generate buzz, and expand their audiences.

Yet creating a hashtag does not automatically mean the company owns it, says Kumar. Hashtags are susceptible to hijacking, in which competitors or consumers use the hashtag for unofficial messaging—like when McDonald's attempted to generate positive publicity with #McDStories but instead received thousands of complaints about the fast food chain.

So, how can a company protect its social media reputation? For some, the answer lies in trademarking.

"The trademark protection of hashtags can increase consumer confidence," says Kumar. Since the U.S. Patent and Trademark Office began allowing hashtags to be registered trademarks in 2013, more and more companies are protecting their intellectual social media property. In 2015, nearly 1,400 hashtags were submitted in trademark applications. "It prevents other competitors from using similar hashtags to mislead consumers."

However, trademarks may come with a price. "Trademarking a hashtag may prevent or restrict its use," Kumar says. The successful spread of a hashtag lies in its ability to be used by anyone, connecting millions of Twitter threads and Instagram photos into one conversation. By trademarking, companies could be stifling this kind of organic engagement.

Little research has been done to understand whether a trademarked hashtag makes a firm's social media audience more or less engaged. Kumar, along with Naveen Kumar of the University of Memphis and Liangfei Qiu of the University of Florida, wanted to know: does trademarking a hashtag defeat its original purpose?

Kumar and his co-authors investigated the tension in these two opposing sides—the organic nature of a hashtag and the restrictive nature of a trademark—in their paper, "A Hashtag is Worth a Thousand Words: An Empirical Investigation of Social Media Strategies in Trademarking Hashtags."

The researchers compared firm-level tweet data from 102 companies, split between a "treated" group of companies who had trademarked a hashtag between 2014 and 2017 and a "control" group of similar firms. The study compared tweets from before and after the hashtag's trademark approval, analyzing the level of engagement through likes, comments, and tweets, as well as the linguistic content of the tweet, including its emotions, tone, and style.

THE SUCCESSFUL SPREAD OF A HASHTAG LIES IN ITS ABILITY TO BE USED BY ANYONE, CONNECTING MILLIONS OF TWITTER THREADS AND INSTAGRAM PHOTOS INTO ONE CONVERSATION.

Based on this study, Kumar and his colleagues discovered some key factors of making a trademarked hashtag work for a company:

1

Companies that trademark hashtags have higher social media engagement.

This study is the first to identify that trademarking hashtags can improve firms' engagement with its audiences on social media—though the effects have varying levels of intensity for different types of firms and social strategies. "Trademarking a hashtag can increase the number of retweets by 27 percent," says Kumar, "which is a considerable amount."

Yet firms can not trademark hashtags arbitrarily. The U.S. Patent and Trademark Office treats hashtags like any other trademark: in order to be approved, the company needs to prove that the hashtag is a key part of the firm's identity and that trademarking works in the consumers' favor by preventing or reducing confusion.

2 Trademarking hashtags works better for smaller, less popular companies with fewer Twitter followers.

While the study demonstrates that trademarking increases social media engagement, Kumar and his colleagues investigated how this effect varies among different types of firms. After comparing the companies in the top and bottom percentiles in terms of Twitter followers, the researchers found that firms with fewer Twitter followers had more significant increases in their engagement after trademarking hashtags than companies with larger followings.

Kumar hypothesizes that small companies see larger positive effects because fewer consumers are aware of their brands and products. "Without trademark protection, other competitors can easily use similar hashtags to mislead consumers," he says. "In contrast, for popular firms with more Twitter followers, it is more difficult to mislead consumers, even in the absence of trademark protections."

3 Writing styles are more important to firms that use trademarked hashtags.

The researchers also studied how companies used language in their social media strategies to understand the key drivers that cause trademarking hashtags to increase engagement. "This is based on the assumption that the way that people use words reflect how they think," says Kumar. For example, using pronouns can reflect a self-centered focus, or using prepositions and conjunctions can indicate a more nuanced thinking.

The study found that when hashtags are trademarked, a firm's writing style becomes more important to its social media engagement. "People tend to like a more narrative and informal writing style in tweets," Kumar says. The researchers saw that more positive, colloquial, and confident writing increase retweeting by up to 10 percent.

4 Effects of increased social media engagement last longer when hashtags are trademarked.

Recognizing that trademarking is a lengthy and expensive process, the researchers sought to discover whether the increased engagement lasted in the long term.

"Before trademarking hashtags, writing more tweets with desirable linguistic styles has only a contemporaneous effect," says Kumar, meaning that the tweets' increase in engagement was immediate, but dropped off quickly. After one month, it was no longer significant. "Trademarking hashtags makes things different," Kumar says. After trademarking, the researchers found that the effects of increased engagement were still happening a month later.

Based on their research, Kumar and his colleagues believe that, especially for smaller companies with fewer followers, trademarking their intellectual social property, like hashtags, is a worthwhile investment. However, to get the maximum bang for your buck, Kumar suggests that companies consider the longevity of their chosen hashtag.

Social media can be fleeting, so invest wisely.

WHAT MAKES A TRADEMARKED HASHTAG WORK?

+ THE RESEARCHERS ANALYZED **102 COMPANIES & 65,000 TWEETS** AND DISCOVERED WHEN TRADEMARKING A HASHTAG WORKS BEST.

27% MORE RETWEETS

Trademarking a hashtag can increase the number of retweets by 27%. This study is the first to identify that trademarking hashtags can improve firms' engagement with its audiences on social media.

5,000 FOLLOWERS

Trademarking hashtags works better for smaller, less popular companies with 5,000 or fewer Twitter followers. It's possible that small companies see larger positive effects because less consumers are aware of their brands and products.

10% MORE RETWEETS

Writing styles are more important to firms that use trademarked hashtags. More positive, colloquial, and confident writing can increase retweeting by up to 10 percent.

30 DAYS

When hashtags are trademarked, the effects of increased social media engagement last longer. After trademarking, the tweets' increased engagement were evident even a month later.

will uber

BUY ME A BENZ?

BY SARAH DIOMANDE

As consumers, we have said goodbye to hailing taxi cabs in the pouring rain. We have stopped stressing about public transit schedules and delays. Some of us have even found alternative solutions to a costly ambulance ride.

Instead, we just get an Uber.

Ride-sharing platforms like Uber and Lyft are one of the biggest ways people participate in what is known as the "sharing economy," through which individuals share goods, like homes and condos on Airbnb and VRBO, or services, like labor and freelance work on TaskRabbit and Upwork.

For many, participating in the sharing economy as a consumer is freeing. But how have the suppliers—those who own cars or homes—been affected in the last decade?

Jing Gong, assistant professor of Management Information Systems at the Fox School, sought out the answer.

+ CONSUMER OR CONSUMED?

Using Uber as an example, Gong could see two sides of the same coin. On one hand, the demand side, consumers who use Uber might be more willing to give up their cars in favor of the convenience of temporary ownership, what she called the "cannibalization effect."

On the supply side, however, Gong could also see that providers may have an incentive as well. Drivers—or those desiring to be drivers—may actually invest in their cars in order to capitalize on the income available in the sharing economy.

To discover the answer, Gong and her co-authors—Brad Greenwood, associate professor of Information and Decision Sciences at the University of Minnesota's Carlson School of Management, and Yiping Song, associate professor of Marketing at Fudan University's School of Management—investigated Uber's entry into different cities in China. Using a unique dataset of new personal vehicle registrations between 2010 and 2015, Gong

and her colleagues analyzed new car purchases compared to Uber's introduction to the country starting in 2013.

Because Uber came to different Chinese cities at different times, the research team was able to use a statistical technique called difference in differences, which mimics a lab experiment, to compare groups classified as controlled or treated. As the platform rolled out, the team used variables in both geography and time to understand Uber's effects compared to the control cities.

In the paper, "Uber Might Buy Me a Mercedes Benz: An Empirical Investigation of the Sharing Economy and Durable Goods Purchase," the researchers found that both riders and drivers have become consumers.

"The consumption of Uber needs to be satisfied by more cars being available," says Gong. "As more people are giving up on public transportation or car ownership, others are seeing the opportunity of becoming a driver, which in return calls for an increase in car sales and trade-ins."

ENTREPRENEURS WITHOUT RED TAPE

The sharing economy has made way for entrepreneurs, sans the red tape.

Gong's study found that Uber's arrival to a city was correlated with an increase in new vehicle ownership—about eight percent on average. The researchers estimated that roughly 16 percent of new owners were purchasing their cars in order to become Uber drivers.

The effects were varied when the researchers analyzed key conditions. First, Uber had a stronger effect on the sale of smaller cars than larger cars, with owners placing a high premium on features like fuel efficiency. Second, women were less affected by Uber's entry into a marketplace, but still experienced a significant increase in car ownership. Finally, young people were more significantly affected, given their higher likelihood to drive for ride-sharing platforms, change jobs, and have more volatile income.

Now, having a car or a home has allowed owners to see an opportunity for financial gain. For those who are unemployed or underemployed, ride-sharing has given them the tools and flexibility of a consistent income.

EFFECTS FROM DETROIT TO D.C.

In this study, the researchers disprove a popular myth that Uber's arrival has people fleeing car ownership. Knowing that buyers are now looking to purchase goods specifically for participating in the sharing economy, how should manufacturers react?

"In order for drivers to stay current while being cost-efficient, they are paying attention to the type of cars they are buying," says Gong. "Whether it is for style or fuel economy, manufacturers are willing to market specific vehicles in order to draw in drivers."

With Uber and other platforms, workers are bypassing the formalities of employment regulations. While lawmakers have highly regulated incumbents in the industries, like taxi companies and professional car services, startups have not had to contend with such high obstacles.

"Policymakers are having to reconsider whether this business model can sustain itself without intervention," says Gong. She suggests lawmakers be thoughtful about reducing regulations on these established industry players to provide a level playing field.

A NEW FRONTIER

It is evident that platforms like Uber have changed the economic game faster than industries can keep up.

"The sharing economy is changing the landscape because it's consumer to consumer," says Gong. "The dynamics are different because the drivers are consumers of cars but the riders are also consumers of cars. With the manufacturers in the mix, there are more players."

This research, the first of its kind to analyze the impact of the ridesharing economy on car owners, can provide insights to industries across the sharing economy. The introduction of Airbnb, for example, could encourage more homeownership for those looking to make money in new hot rental markets. Manufacturers of these goods will need to understand, build for, and market to these new customers.

Powered by new technologies and an entrepreneurial spirit, the sharing economy will continue to grow in both importance and prevalence. Yet, the question remains:

Is a new Mercedes in your future?

on etsy, socialize for
SALES

BY SARAH DIOMANDE

ETSY—THE ONLINE TREASURE CHEST FOR ALL THINGS HANDMADE—CULTIVATES A COMMUNITY FOR THOSE WHO HAVE A KNACK FOR CRAFTS LIKE CANDLE-MAKING, KNITWEAR, JEWELRY, OR POTTERY. WITH OVER 1.7 MILLION ACTIVE VENDORS AND CLOSE TO 28.6 MILLION ACTIVE CONSUMERS, ETSY HAS ESTABLISHED A PEER-TO-PEER BUSINESS PLATFORM THAT ELIMINATES THE MIDDLEMAN OF CORPORATE PRODUCTION. YET THIS MARKETPLACE IS MORE THAN JUST AN E-COMMERCE SITE; IT IS A COMMUNITY OF LIKE-MINDED INDIVIDUALS WHO APPRECIATE HANDICRAFTS.

Within the site, buyers and sellers interact through a variety of IT-enabled features, like following and messaging shops, reviewing and favoriting products, and curating lists of products. Yet as sellers socialize by favoriting and promoting others' products, are they redirecting potential customers away from their shops?

Professor Sunil Wattal and doctoral student Ermira Zifla of the Management Information Systems Department at the Fox School of Business investigate how social mingling affects e-commerce marketplaces in their paper, "Understanding IT-enabled Social Features in Online Peer-to-Peer Business for Cultural Goods."

"What really fascinated us about this platform is that you have this community aspect, but you are also introducing this e-commerce agenda," says Wattal.

"We thought that sellers may have mixed incentives to participate in the online community," adds Zifla. "On the one hand, participating by following others and posting in forums may increase the visibility of sellers and subsequently increase their sales. On the other hand," she continues, "following other sellers and sharing their products could negatively impact sales by diverting traffic away from their own page."

While online communities have often been the subject of research, this is one of the first studies to link social indicators with economic performance. Using a dataset of nearly 2,000 sellers on Etsy, Wattal and Zifla examined their interactions in the online community and found how socializing with others can inherently affect a shop's sales.

The researchers identified two categories of social e-features that promote new products and validate users:

1. Community participation features—such as following other sellers and joining teams—which facilitates socializing with other members, and
2. Content curation features—such as curating favorite lists, sharing products, and favoriting shops—which serve as tools for validation and tastemaking.

"When you are following other people on Etsy, those people are listed on your page as a form of validation, for what you like to buy as a consumer or what you can provide as a producer," said Wattal.

The researchers hypothesized that community participation and content curation would increase a seller's online status by increasing their number of followers, but would decrease a seller's sales by diverting attention away from their own products.

Using a web crawler to collect public information, the pair obtained a dataset of 1,728 unique glass sculpture sellers—a randomly chosen subcategory of marketplace shops on Etsy—to compile a year's worth of data, including sellers' followers, lists, favorited products, and sales.

Analyzing the data proved the researchers' hypotheses correct: a 10 percent increase in community participation, like following other sellers, and content curation, like favoriting products, resulted in a 3.89 percent decrease in sales. Yet this reduction was outweighed by the affects of cultiativing a stronger social following. In other words, the same activities that led to a direct decrease in sales helped sellers attract more followers, and were associated with an indirect increase of sales by 4.64 percent—an overall net gain.

"IT-enabled features have benefits that supersede the negative," says Wattal, "since exposure is what can ultimately lead you to be on an influential list or you can simply commercialize yourself to the point of high-status."

Trends can come and go as quickly as a trendsetting blogger changes her mind. Yet in the realm of vintage trinkets and artisanal finds, relationships stay relevant.

BUILDING AN ETSY BUSINESS

10% INCREASE IN...	LED TO...
TEAMS JOINED The number of teams joined, a community feature similar to online forums where sellers can chat, organize events, and seek advice	**1.7%** ↑ increase in followers **0.4%** ↓ decrease in sales
PEOPLE FOLLOWED The number of people whose activities a user is following	**1.5%** ↑ increase in followers **0.8%** ↓ decrease in sales
COLLECTIONS CURATED The number of treasury lists created, where users publically highlight collections of others' products	**1.5%** ↑ increase in followers **1.7%** ↓ decrease in sales
MARKED FAVORITES The number of products from other sellers a user marked as "favorites"	**1%** ↑ increase in followers **0.9%** ↓ decrease in sales
FOLLOWERS	**8.2%** ↑ increase in sales
IN TOTAL **10%** ↑ increase in use of social features	**RESULTED IN** **3.89%** ↓ direct decrease in sales **4.64%** ↑ indirect increase in sales

Overall effect is a positive increase of

0.744% ↑

A FRIEND OF A FRIEND:

expanding peer influence

BY MEGAN ALT

How much do friends-of-friends' opinions influence you? The answer is, perhaps more than you think.

There are two types of neighbors in a social network: the ones you know directly, and the ones your friends know. Research has shown that direct peers have significant influence in social networks, from joining Facebook to subscribing to Netflix. Yet indirect neighbors—those with whom you have a mutual friend, but do not interact directly—can also affect behaviors.

"People want to know what others think of them," says Paul A. Pavlou, senior associate dean of research and professor of management information systems at the Fox School, "especially those in similar positions. In order not to lose influence, an individual would eventually make the same judgement and same decision as his peers."

Pavlou, alongside co-researchers Bin Zhang of the University of Arizona and Ramayya Krishnan of Carnegie Mellon University, studied how direct and indirect peers influence groups by using Caller Ring Back Tones (CRBT) adoption in Asian cellphone markets, in a paper published in *Information Systems Research* in 2018. In analyzing 200 million calls from 1.4 million users, the researchers overcame statistical and computational challenges of the immense dataset by using subpopulations of 200 or 500 people, each group its own network of friends.

The researchers found that, in the larger group, indirect peer influence has a significant positive effect. In the case of CRBTs, a caller's knowledge of her acquaintances' use of ringback tones encourage her to be "on-trend" and thus adopt the same behavior. Yet in a smaller group, a caller has a greater desire for individuality, resulting in a decision not to adopt.

This study sheds more light on the complicated, large-scale networks that exist today. By understanding how peer influence works with both direct and indirect neighbors, businesses can learn the best strategies for things like product diffusion, content creation, and software adoption within social networks. "If businesses want to trigger higher adoption rates, then for smaller groups, they only need to focus on individuals with many direct connections," says Pavlou. "For larger groups, they should not only focus on popular individuals, but also those who have many common friends."
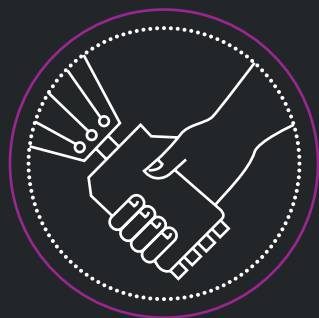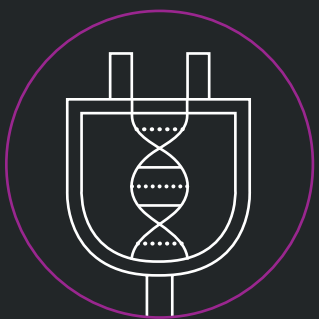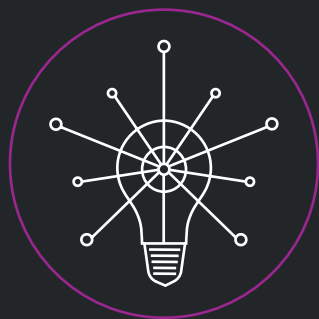
—
+ is personalized education the future of

LEARNING?

BY SARAH DIOMANDE

A personalized touch can make all the difference.

When you log into Amazon, Netflix, or Facebook, one of the first things you see are recommendations for products, shows, or friends you may know—all based on things you have already bought, watched, or liked.

Recommender systems have eliminated the time-consuming effort of understanding and anticipating what exactly users want, sometimes before they know they want it. Using vast collections of detailed data points, data scientists can create a trail of digital breadcrumbs, which follows Internet users as each sale, search, and interaction becomes part of an algorithm for new suggestions. These platforms can predict and encourage your next shopping sprees, binges, and bucket lists.

In the private sector, companies have long been using technology-enhanced learning in order to proactively suggest and anticipate their consumers' choices. But how can these mechanisms be most effectively applied to academia?

"We have to learn something new every day," says Dr. Konstantin Bauman, assistant professor in the Management Information Systems (MIS) Department at the Fox School of Business. "With the traditional path, we go to university, take some courses, meet with the instructor once a week, and go to lectures. But today, there are many different types of tools and materials available online that are able to educate large groups in a personalized and direct way."

Educational companies like Coursera, Lynda.com and the Khan Academy already use recommender systems to suggest courses their users may like, based on their history. Bauman, however, wanted to know whether personalized e-learning can help students struggling to comprehend a particular subject.

"Education is one important application of recommender systems for society to target materials for specific learning paths," says Bauman.

Bauman, along with co-author Alexander Tuzhilin of New York University's Stern School of Business, examined the personalized e-learning systems approach with the help of a tuition-free online university. By using curricula from 42 classes and test results from 910 students over three semesters, the researchers created a system to pinpoint— and address—specific areas within a student's comprehension that needed improvement.

The team reported their findings in the paper, "Recommending Remedial Learning Materials to Students by Filling Their Knowledge Gaps," which was published in *MIS Quarterly* in 2018.

In this real-life experiment throughout the 2014-2015 academic year, Bauman's team identified where students' knowledge waned and provided materials to supplement these gaps. "Instead of revising the entire lesson, we provided catered lessons to fill those gaps," says Bauman.

The students had diverse backgrounds, from both the United States and developing countries, and studied in a variety of programs, from business to computer science to art history. The researchers split the students into three groups: a control group that received no recommendations, a group that received non-personalized recommendations, and a group that received recommendations tailored to the individual student.

Bauman and his team created taxonomies that mapped all the topics covered within a specific course, built a library of remedial learning materials, and matched test questions with course topics. After analyzing test scores, the researchers identified the students' weaknesses. The students in the non-personalized group received generic recommendations for the course, while students in the personalized group received remedial materials for specific topics that were identified via testing.

"First, we showed that most of the students who received our recommendations found them relevant and helpful," says Bauman. Second, the "average" students, who received a test score between 70 and 90 in previously taken courses, were most affected by personalized recommendations. "These students improved their performance on the final exams significantly more, in comparison to their prior performance before they received personalized recommendations, than the students from the control group." For this subset of students, the personalized group received an average grade of 83.22 in their final exams, while the control group scored an average of 79.39.

The study received limited interactions with students who were classified as "falling behind" (those whose previous grade averages were below 70) as only six students who received personalized recommendations actually clicked on the materials. Similarly, students who were "excellent" (with average grades above 90) were less likely to need remedial lessons.

Bauman found that, by determining specific materials needed to supplement their understanding, students saved time and energy in preparation for their exams.

"Learning systems have the capability of picking up patterns and behaviors that can clearly predict necessary methods that are worthwhile and timely," says Bauman. For students and professors, time that may be used to teach a specific lesson can be accomplished through recommender systems, saving more time for interactions that encourage new ideas and understandings.

One thing is for sure—when it's time to come back for more, a new suggestion will be waiting.

calculating
NEW IDEAS

BY MEGAN ALT

EACH YEAR, CONSUMERS CREATE 16.3 ZETTABYTES OF INFORMATION—ENOUGH TO FILL OVER 127 BILLION IPHONES. SORTING THROUGH ALL THIS INFORMATION IS LIKE TRYING TO FIND A NEEDLE IN A HAYSTACK THE SIZE OF CALIFORNIA.

Within these treasure troves of data are valuable insights waiting to be discovered. Data scientists use statistics, math, and information technology to sort through enormous datasets with millions of variables, looking for patterns. Yet combing through this information takes immense power, not to mention computer memory. So do they sort through it all?

That's where people like Zhigen Zhao, associate professor of Statistical Science at the Fox School, come in.

Zhao and his statistician colleagues invent new ways to use statistics, overcome computation limitations, and see patterns through the noise. Their discoveries range from a patent-pending methodology that enables users to analyze millions of data points in seconds to a new threshold for pinpointing statistical significance.

DECIPHERING GENETIC CODES

Humans have 20,000 genes in our DNA. Much like data, decoding how each gene interacts with another can provide valuable insight, in this case into a person's health. With over 190 million possible pairs, that's a lot of variables to test.

"Years ago, 10,000 was considered a big data set, but not anymore," says Zhao. When using standard algorithms like distance correlation, statisticians run into issues with computation speed, and the old algorithms can't keep up with the large datasets available today.

Zhao and his colleagues devised a methodology that can analyze all of these variables in seconds. "Our method only takes two-tenths of a second to finish this kind of calculation," says Zhao. His computer would crash when using older algorithm to analyze a dataset of that size.

"People's health can depend on a specific combination of their genes," says Zhao. This revolutionary methodology, which is currently patent-pending, can identify certain combinations of genes that may help doctors understand medical issues ranging from heart disease and Alzheimer's to obesity and alcoholism.
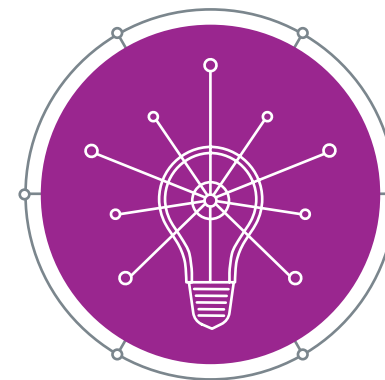
DISCOVERING DIFFERENCES IN EDUCATION

With millions of pieces of information, statisticians and data scientists often grapple with the problem of false discoveries—inferring a pattern that is not truly significant. Statisticians try to account for these false discoveries, but this may lead to a less complete picture of the data.

Zhao and his colleagues created a new algorithm to reduce the number of false discoveries while keeping more pertinent patterns than other methods. Zhao's team applied this algorithm to school districts in California, analyzing standardized test scores of students from over 4,000 elementary schools.

The researchers compared pass rates from two groups of students, the socioeconomically advantaged and the socioeconomically disadvantaged. Normally, the advantaged students will have higher scores than their disadvantaged counterparts. However, Zhao used his algorithm to identify schools that have unusually small or unusually large differences between the two populations—where the disadvantaged students were either significantly underperforming or overperforming in statewide math tests.

Their new algorithm found more schools whose populations have significant differences in test scores, providing a more complete understanding of the dataset. "The main idea for this method is to set up a new threshold," says Zhao. "Sometimes, the standard value for statistical significance is overly conservative. We wanted to know what is the proper number that should be used." This kind of refined analysis can help district and state policymakers to reallocate resources to support underperforming schools or to imitate overperforming schools.

From education to healthcare and everything in between, Zhao and his fellow statisticians sort through enormous datasets, finding new ways to compute that better our everyday lives.

HARNESSING THE POWER OF BIG DATA
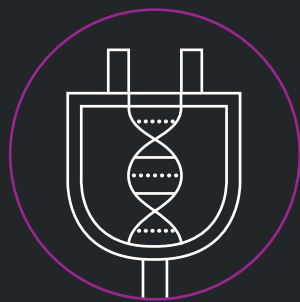
Temple University's Data Science Institute serves as the umbrella that unites research efforts across the university. Led by Paul A. Pavlou of the Fox School and Zoran Obradovic of the College of Science and Technology, the Institute fosters academic, practice-oriented, and translational research across disciplines, uniting areas of research excellence from healthcare, computer science, engineering, education, and business to solve problems and discover groundbreaking insights.

The Data Science Institute takes advantage of the Fox School's Department of Statistical Science, one of three such departments housed in business schools in the country, which brings the application of high-dimensional statistics to the institute's efforts. With deep expertise in the theoretical, methodical, and analytical underpinnings of data science, the Fox School works collaboratively with other disciplinary areas to study research business challenges in various fields, from computer science and engineering to biology and medical sciences.

Each of these articles feature award-winning research from across Temple University that received funding through the Data Science Institute.
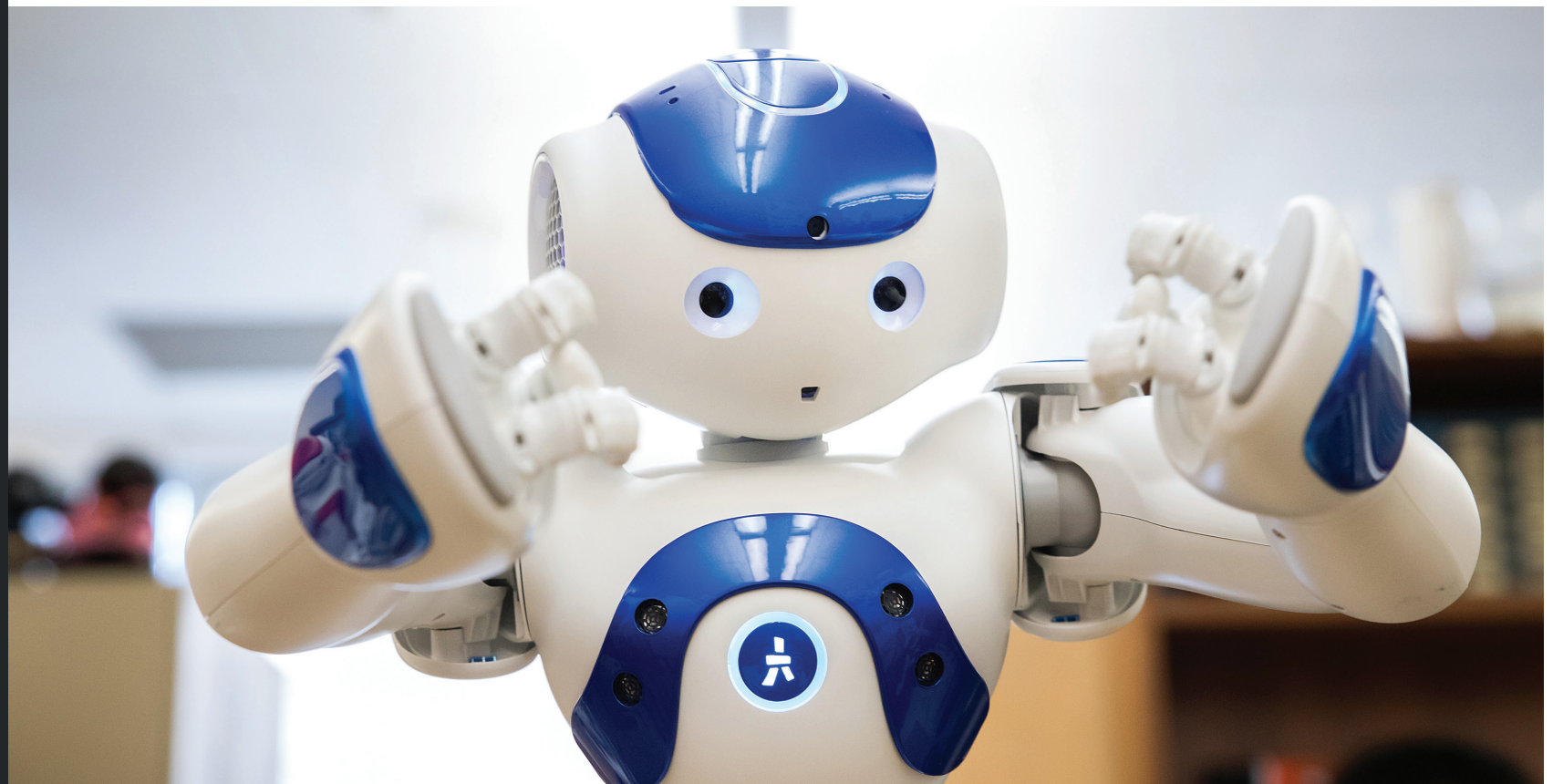
how a robot reaches kids on the

AUTISM SPECTRUM

BY JOY MANNING

MEET NAO.

NAO CAME TO TEMPLE UNIVERSITY ABOUT FOUR YEARS AGO, WHEN LI BAI AND CAROLE TUCKER, RESEARCHERS FROM THE COLLEGES OF ENGINEERING AND PUBLIC HEALTH, AND, JOINED BY HEIDI GRUNWALD, DIRECTOR OF TEMPLE'S INSTITUTE FOR SURVEY RESEARCH, TO STUDY ROBOTICS AND SURVEYS.

a one-foot-tall robot with a cute robotic voice such as NAO is asking questions instead of a human clinician, researchers might get reliable patient reported outcomes in a way they have not been able to in the past.

The team's research would also include another stream of valuable information: para-data. The camera inside the robot would "watch" the subject as NAO asked the survey questions. Additionally, via the sensor the subject wears (a Microsoft wristband), researchers can monitor things like facial expression, heart rate, and body motion. This para-data is a rich vein of knowledge, particularly when combined with the survey questions, response time, and answers.

If the subject pauses an extra long time when a certain question is asked, the NAO can play a game (like rock, paper, scissors), take a break, or give a high five to reduce anxiety. This is one way that the robot uses para-data to adapt to a child's answers. The para-data also helps the researchers better understand survey responses. "For example, we can tell if a particular question made a subject nervous and then down-weight the answer, or not count it," explains Grunwald.

"The robot's face is much less complex than a human face and human facial expressions," says Tucker. That makes it much less overwhelming for a young person on the autism spectrum who may find it challenging to read people's faces and maintain eye contact.
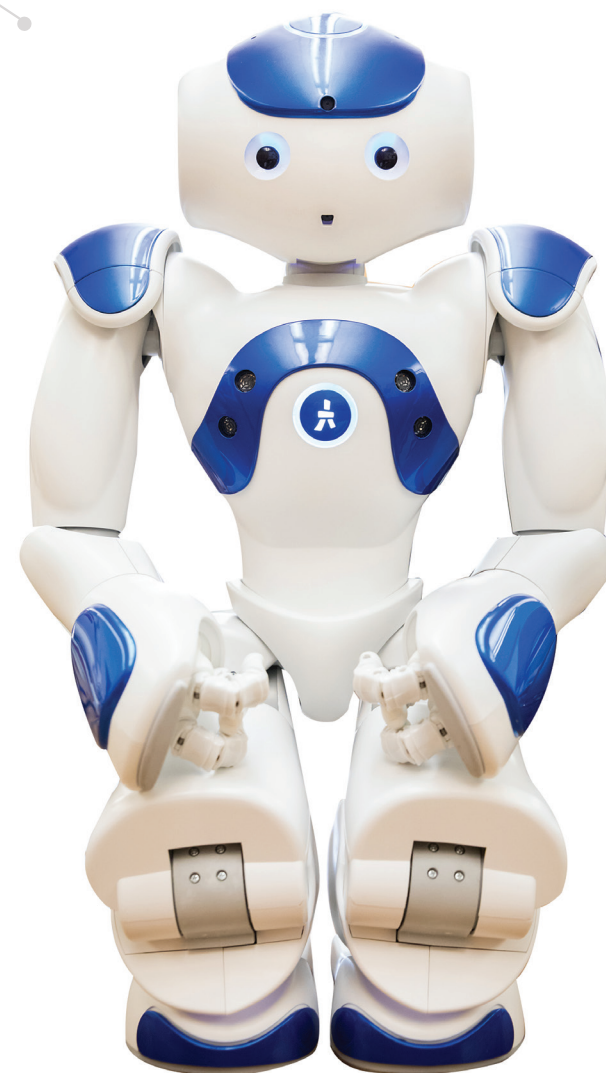
Their project received funding through the Office for the Vice

President of Research's Targeted Grant Program at Temple University, with matching funds from all three represented schools.

Planning the research has been an iterative process. On the computer science side, Bai and his engineering students have been exploring the feasibility of using NAO this way. Bai and the students have been answering questions like, "What features would be nice? How can we use sensors to pull in data and incorporate the Microsoft band?" They have iterated and refined the data architecture, a database where the data are meshed together so that the robot can read all of the survey response data—coupled with the para-data (sensor data).

Meanwhile, the questionnaire and para-data collection process has been tested on different groups, starting with older kids not on the autism spectrum. As trial subjects, children aged 10 and up can provide specific, meaningful feedback on interacting with NAO. More recently, a community event brought a group of children on the autism spectrum to campus, and the team had an opportunity to see NAO interact with the intended study subjects. Going forward, they have the kind of pilot data that can win the funding to drive this effort forward.

This work can benefit groups beyond younger people on the autism spectrum. Any time data reported directly from a patient may be skewed or inaccurate—such as dementia patients, for example—the survey methods used in this work could prove enormously helpful to clinicians.

+ The team wanted to explore a big idea: What if NAO, this cute, two-foot tall, human-ish robot, could be programmed to give health surveys to children on the autism spectrum? Could they create a system to collect patient-reported outcomes in this tough-to-survey population?

Potentially, this research could solve a number of difficult problems. Currently, it's parents that fill out surveys on behalf of their kids. Researchers would prefer patient-reported outcomes. It's much more accurate than information filtered through a third party, such as a parent. "Kids with autism may be willing to say they are depressed, but not in front of their mother," says Tucker. When

NAO:

1 — **COSTS $8,000,**
making scalability an issue for the researchers.

Stands nearly
2 — **2 FEET TALL**

Weighs over
3 — **12 LBS**

Recognizes more than
4 — **20 LANGUAGES**
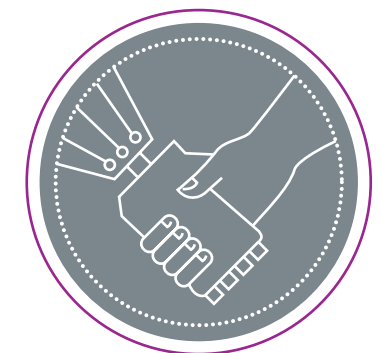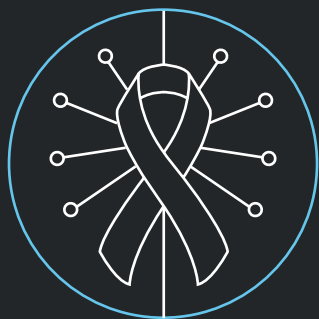
Has 25 degrees of
5 — **FREE MOVEMENT**

+ "With future improvement in this type of research, I think we will see more robotic diagnostic platforms that will be developed. One of the functionalities will be surveys of the patients about their health conditions. It could be particularly important for people who can not find a good hospital in their neighborhood," says Bai.

Practical applications of this work in the future aren't limited to the realms of research and medicine by any means. "Artificial intelligence and robotics will be the next technology push to drive the economy of our country. There will be countless business world applications—such as personal robotic assistants (such as the iPhone's Siri) or self-driving cars," says Bai. He believes that the technology in this project will fuel innovations across all sectors of the economy in the years to come.

+ how big data can

COMBAT ADDICTION

BY JOY MANNING

More than 15 million adults struggle with alcohol addiction. In fact, according to the CDC, one in ten deaths of working-age adults in America is linked to alcohol. That's one reason data on alcohol use has been chosen by researchers for study from the enormous data set from the U.S. Department of Veterans Affairs' ambitious Million Veteran Program (MVP). The VA intends, as the project's name states, to gather data on an astonishing one million service members.

Kuang-Yao Lee, assistant professor of statistical science at the Fox School, sees a world of potential new knowledge in this vast cache of data. This is particularly true of alcohol use because the data from the MVP is longitudinal, which means the same measurements are tracked over time. Alongside the support from the VA, Lee's project received funding through from Office for the Vice President of Research at Temple University.

Volunteers in the MVP each submit blood samples as well as health surveys, amassing a dataset that comprises both genetic data and behavioral patterns. Beginning in 2016 when he was a researcher at Yale University, Lee and his colleagues have been using this information-rich resource to search for the specific combination of genes that corresponds to alcohol and other substance use.

"Previous studies have suggested [these genes exist], but mostly were only limited to small scales or restricted conditions," says Lee. "We want to use statistical models to find out if this is really a valid assumption. Our results so far suggest a very strong association."

While ample electronic health records and genetic data have long been available to researchers, only recently has the efficient computing power become available to slice and dice the information into accurate, usable new insights and discoveries. More sophisticated algorithms combined with larger-than-ever computer storage capacity, as well as parallel computation techniques, allow today's researchers to make meaning from a huge amount of complex data.

How huge? "Depending on the facility, the whole genome sequencing [for one person] can produce hundreds of millions of variants," says Lee. Questionnaires allow researchers to gather large amounts of information about each subject every time they are administered. Multiply that by one million veterans. "We're talking about not just billions, but millions of millions points of data," he says.

Data with this level of complexity can lead to findings that are more nuanced and reliable than in the past. Previously statistics sometimes led to oversimplified and other not-quite-right conclusions. We've all heard the old axiom, "There are three kinds of lies: lies, damned lies, and statistics." But as so-called big data increases in scope and complexity and the tools used to analyze this data become more sophisticated, statistics
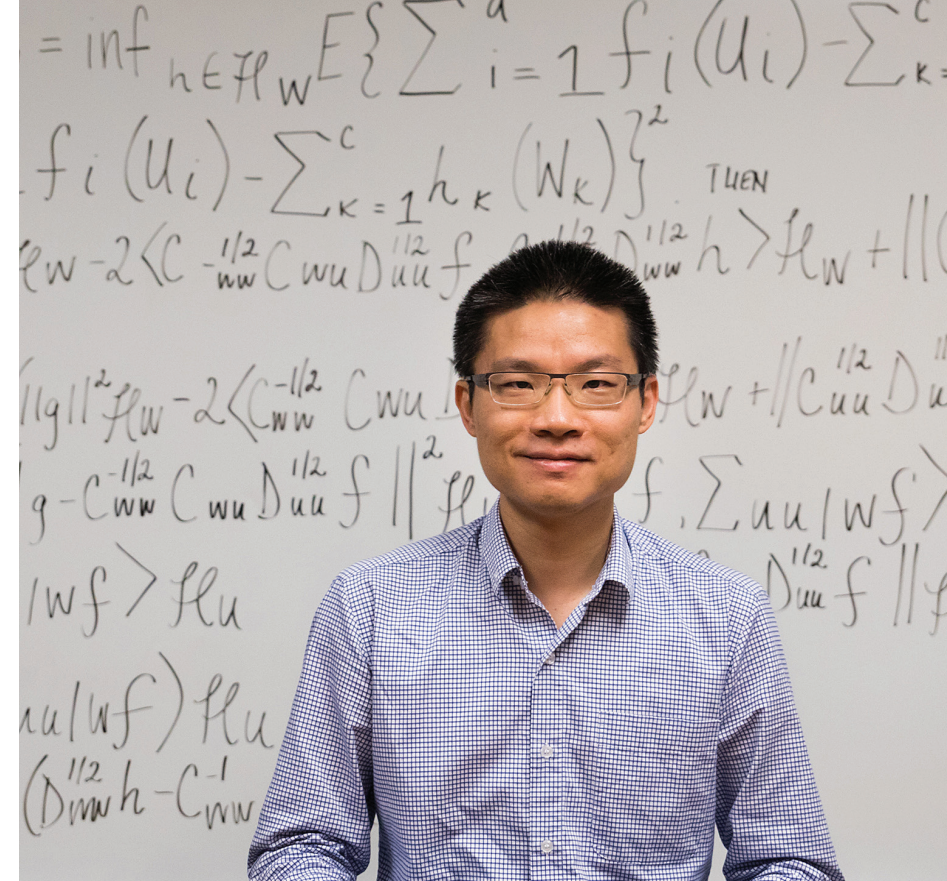
are becoming more honest than ever before. From projects such as the Million Veteran Program and other similarly vast datasets, new genetic truths may ultimately emerge.

There are many possible real-world applications for this research. For one thing, determining which specific genes are linked with alcohol and other substance abuse could lead to new and better medicines and treatments for the very veterans who have volunteered their most sensitive personal information for this work. A dialed-in genetic profile that indicates a vulnerability for substance abuse could be used to screen kids and even adults while there is still time for effective early interventions that can keep them on a healthy path. Given the current public health crisis around opioids, alcohol, and other substance use, a breakthrough of this kind could have far-reaching benefits.

Lee says that the knowledge gleaned from the Million Veteran Program about substance abuse may lead to similar projects that could help solve other vexing behavioral, health, and genetic puzzles. He also notes that the innovative statistical models and tools he's used in this research could be applied in myriad ways to other complex datasets.

For example, online shopping platforms can easily observe huge amounts of individual consumers and, at the same time, collect data across a large number of variables. "One of the core problems in business analytics is to use statistical models to study the inter-dependency between observed variables, for example, the dependency between decision making and consumer behavior," Lee says.

"There are a surprising number of similarities between genomics and online shopping."

Kuang-Yao Lee

BREAST CANCER BREAKTHROUGH

BY JOY MANNING

Carlos Barrero

Oscar Perez-Leal

IT'S THE MOMENT EVERY WOMAN DREADS: A ROUTINE BREAST SELF-EXAMINATION DURING AN OTHERWISE RELAXING SHOWER ENDS IN THE PANIC-INDUCING DISCOVERY OF A LUMP.

Often, what happens next is a long, harrowing journey through a combination of biopsies, surgery, chemotherapy, and radiation. While it's true that, thanks to advancements in screening and treatment, more and more women survive breast cancer, it's also true that 80 percent of breast cancer cases have already advanced to an invasive stage at the time of diagnosis.

Today, just 20 percent of breast cancers are identified at the earliest stage, when treatments most effective and the five-year survivorship rate hovers near 100 percent.

Carlos Barrero, MD, and Oscar Perez-Leal, MD, assistant professors in the Pharmaceutical Sciences Department at Temple University's School of Pharmacy, wants to change all that. "I believe we can invert those numbers so we're discovering 80 percent of breast cancers at the very earliest stage," he says.

The research Barrero and Perez-Leal are conducting may represent a major breakthrough in breast cancer screening. Their work could lead to a simple routine blood test that detects breast cancer sooner than ever before for more women. To do this, Barrero and Perez-Leal are working on identifying a set of biomarkers for breast cancer, a specific signature of early-stage breast cancer detectable in a blood sample.

Their work on this project received funding through the Office for the Vice President of Research's Targeted Grant Program, and the team is currently in the process of securing additional funding from the National Institutes for Health, and the National Cancer Institute. Perez-Leal is also using the knowledge gleaned from his masters degree from the Fox School's Innovation Management & Entrepreneurship program to turn the idea into a feasible product.

Though mammograms are a recommended cancer screening for women age 40 and older, only 65 percent of women over 40 have had one in the past two years, according to the Centers for Disease Control.

"Many women avoid mammograms because they can be uncomfortable, and because of the hassle of needing to make a separate appointment. If screening for early-stage breast cancer became a part of routine blood work, more women would be screened regularly," says Barrero. That would likely result in more early diagnoses, more effective treatment, and ultimately more long-term cancer survivors.

Through systems biology, advances in mass spectrometry technology that allow the detection of very low concentration of proteins and metabolites, and the availability of large public datasets from thousands of breast cancer tumors, Barrero and Perez-Leal can move this cutting-edge work forward. "Most research of this kind starts with analyzing the blood sample. We start by analyzing the data," says Perez-Leal. It's a fresh approach to a longstanding problem.

The researchers start by looking for specific proteins secreted by breast cancer tumor cells across many thousands of samples drawn from breast cancer tumors. The team is searching for a signature set of proteins that can be detected in very low amounts. A vast data set and formidable computing power are essential for finding the precise biomarkers that could, in five to 10 years, lead to the blood test. Recently upgraded mass spectrometry equipment at Temple's School of Pharmacy allows him to carry out this innovative research.

The promise of this research extends even beyond the hopes of early detection into the possibility of new, more effective medicines to battle breast cancer. Going forward, biomarkers are likely to be an increasingly hot topic for those in the pharmaceutical industry, which represents a significant part of the U.S. economy. Biomarkers such as these are often used as a reference point in drug development; when the biomarkers diminish or disappear in blood tests, it's evidence that the new drug is working.

Current treatments for breast cancer are effective, but they come with their own health risks and side effects, some of which lead to different health challenges years after patients have recovered from cancer.
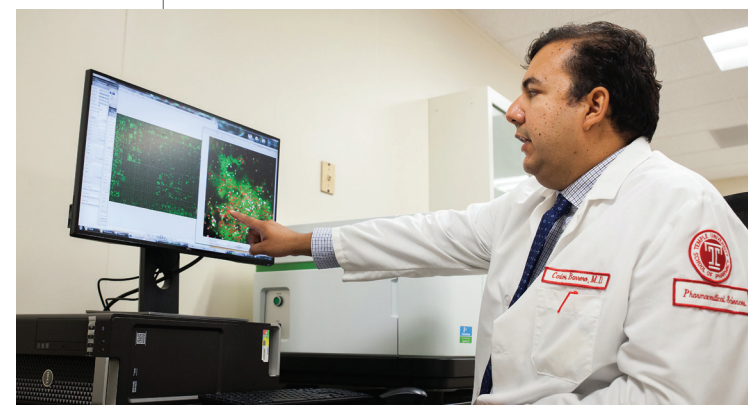
The identification of these biomarkers would also mean that, in addition to early intervention, a breast cancer patient could get a form of personalized medicine, which is another area of potential business growth for the pharmaceutical industry. For patients, that might mean fewer side effects and complications down the line.

"It's rare to find a scientist with a business background," says Perez-Leal. He praises the Innovation Management and Entrepreneurship program with helping him take an idea, establish a business plan, and pitch to investors. "The research community should continue to focus on finding solutions and products to real problems."

Clearly, breast cancer is a real problem, as the most common cancer among women: one in eight will face a diagnosis in her lifetime. But if Barrero and Perez-Leal succeed, it will be a game-changing advance. Many more women will be diagnosed in the cancer's earliest stages, receive more personalized treatment, overcome the disease, and lead long and healthy lives.

for hospitals, information shared is

MONEY SAVED

BY JOY MANNING

SOMETIMES IDEAS FOR ACADEMIC RESEARCH CAN COME FROM THE UNLIKELIEST OF PLACES, LIKE OUT OF YOUR EARBUDS.

HILAL ATASOY, ASSISTANT PROFESSOR OF ACCOUNTING AT THE FOX SCHOOL, WAS HARDLY EXPECTING TO DISCOVER A SUBJECT THAT WOULD LEAD TO YEARS OF STUDY WHILE LISTENING TO A PODCAST, BUT THAT IS EXACTLY WHAT HAPPENED.

"I was listening to a story about a cancer patient," says Atasoy. In addition to being physically and emotionally difficult, having cancer can be costly. The patient explained that during her treatment she had moved and had to change hospitals and doctors several times because of her relocation and other reasons.

"She was saying how difficult it was to keep transferring her tests, results, procedures, and other records. She had to go through this ordeal again and again," recalls Atasoy. Finally, the patient landed at a hospital with a good electronic health records (EHR) system, and she didn't need to go to any extra trouble or expense anymore.

That got Atasoy thinking. Since the HITECH Act of 2009 made the migration of patient information from paper files to electronic health records mandatory, many studies have investigated whether this shift actually benefits hospitals, as electronic health records systems are costly to implement.

The results of previous research, particularly around healthcare costs, have been inconclusive. Studies point to the likelihood that costs actually go up—not down—as electronic health records systems are put into practice, at least for the individual hospital in question. But Atasoy's research looks at changes in the regions surrounding individual healthcare providers. "The question we're asking in the study is whether the impacts of the electronic health records go beyond the adopting hospital."

It's common for someone to have a dermatologist at one hospital, get a mammogram at a different hospital, and see a primary care doctor affiliated with a yet a third institution, especially if that person lives in a city. When you factor in the costs at not only the individual hospital that adopted EHRs but also the costs at surrounding hospitals where there are shared patients, Atasoy has found that there is a marked cost saving benefit after all. Estimates suggest that if one hospital in each area adopts an EHR system, it would add up to a net reduction of $18 billion in healthcare costs nationwide.

To conduct her research, Atasoy relied on several data sets. "We tracked information about the adoption of electronic health records systems at almost all the hospitals in the U.S. from 1998 to 2012," she says. She also used Medicare data, census data, and HIMSS data (a dataset that comprises information about EHR use across the country). Atasoy and her team used statistical analysis software to interpret the numbers and come to their conclusions about the costs and benefits of EHR beyond the walls of any one hospital. Her research was published last year in the journal *Management Science*.

Atasoy notes that implications for her research extend beyond the healthcare sector. "It shows the importance of connections across different organizations. Businesses might be connected, for example, through shared customers," she says. "Obviously, the firms are focused on their customers and their purchases and all the information they have on their customers right within their business, but there are many organizations that share customers or share suppliers. They have these connections."

Her work on hospital-level data led into her current research, which focuses on patient-level data and seeks to identify the cost and quality of care benefits that could come with the widespread sharing of EHR between health institutions. "We've learned that only 20 percent of doctors use

electronic health records, and what we've seen suggests that there are significant benefits to patients when doctors do use them," says Atasoy. This seems to be especially true for patients living with chronic conditions such as cancer, diabetes, or heart disease.

Atasoy hopes her research will help spark a discussion about the value of hassle-free information reciprocity at hospitals, something that, on a policy level, she believes needs to be incentivized. Just as she began to look at the bigger picture, viewing hospitals regionally as a group and not individually, viewing a patient's multi-year health journey and not just a single procedure, she hopes hospital administrators will zoom out, too.

"One big problem with healthcare in the United States is that it's very fragmented," says Atasoy. Her work reveals that a hospital isn't an island and that the free flow of information will ultimately benefit everyone's bottom line.

"THE QUESTION WE'RE ASKING IN THE STUDY IS WHETHER THE IMPACTS OF THE ELECTRONIC HEALTH RECORDS GO BEYOND THE ADOPTING HOSPITAL."

STRIKING BACK AT ZIKA

BY JOY MANNING

VICTOR H. GUTIERREZ-VELEZ NEVER EXPECTED HIS WORK TO LEAD HIM TO THE TOPIC OF PUBLIC HEALTH. HIS EXPERTISE LIES IN REMOTE SENSING SCIENCE, ANALYZING DATA SUCH AS SATELLITE IMAGES. "EVERY DAY, NUMEROUS SATELLITE IMAGES ARE TAKEN," SAYS GUTIERREZ-VELEZ. AND THE INFORMATION DRAWN FROM THESE IMAGES HAS BOTH ACADEMIC AND COMMERCIAL APPLICATIONS.

For example, satellite images can help prescribe management, fertilization, irrigation, and other activities in precision agriculture, according to Gutierrez-Velez. They can help the insurance industry assess risks related to flooding or other natural disasters, or to verify crop insurance complaints. Satellite imagery can allow energy companies to pinpoint the ideal location for solar panels. And this kind of data, it turns out, can even come in handy when it comes to fighting certain diseases.

To that end, partnering with colleagues with expertise in biology and public health, Gutierrez-Velez, assistant professor in the College of Liberal Arts, has recently been drawn to an unlikely research subject: mosquitoes. Specifically, the tiger mosquito (scientific name: *aedes albopictus*). What's so interesting about this tiny, blood-sucking bug?

"It's worrisome. They can spread the Zika virus and other dangerous diseases," says Gutierrez-Velez.

In 2016 when the Zika pandemic caught his interest, mosquitoes dominated the headlines. Once thought to be limited to tropical and subtropical regions, the tiger mosquito had expanded its territory into most continents. Climate change plays a role, but these mosquitoes are also particularly aggressive. They're among the 100 most invasive species in the world. In the 1980s, they were first spotted in the U.S. in Texas. Today, they reach as far north as Connecticut. Their presence in Pennsylvania remains an ongoing public health concern.

For his project, a recipient of the Office for the Vice President of Research's Targeted Grant Program, Gutierrez-Velez decided to look at multiple datasets, including climate data, information gathered from sampling for the presence of the tiger mosquito, land cover data, and census information. Gutierrez-Velez believes that with these and other datasets as inputs, machine learning and advanced algorithms can be used to predict the locations of tiger mosquito populations in advance of the season.
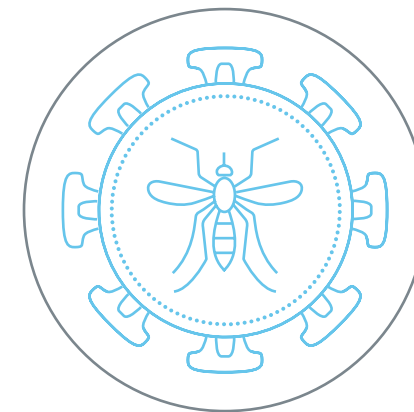
One of the most interesting possible findings of this research is that the tiger mosquito is less of a rural dweller than previously thought. "What we're finding contradicts conventional wisdom about where these mosquitoes live. They are becoming domesticated animals. They prefer to be where lots of humans are living closely together—in cities. Because they love our blood," says Gutierrez-Velez.

Scientific curiosity led Gutierrez-Velez to census data, which is not necessarily an obvious source of information to predict the presence or absence of a small flying bug. "If they feed on humans, human behavior should have something to do with it," he says. And it does seem like including this data makes for a more accurate prediction about where the mosquitoes will go next.

Gutierrez-Velez's ultimate goal for the project is to perfect a reliable working model that can be used to predict the upcoming mosquito season. Knowing that a particularly bad mosquito season is about to start will give officials the opportunity to plan in advance.

For example, the most affected areas can be targeted for treatment before the problem becomes unmanageable. Residents could be strongly cautioned in advance of the season to deal with housing-related conditions, such as places that collect standing water, which act as mosquito breeding areas. In the event that mosquitoes are spreading Zika or another virus, these protections could even save lives.

"There's a lot we can do if we have a model that can say, 'Hey, it's going to be a bad year for mosquitoes, get ready,'" says Gutierrez-Velez.
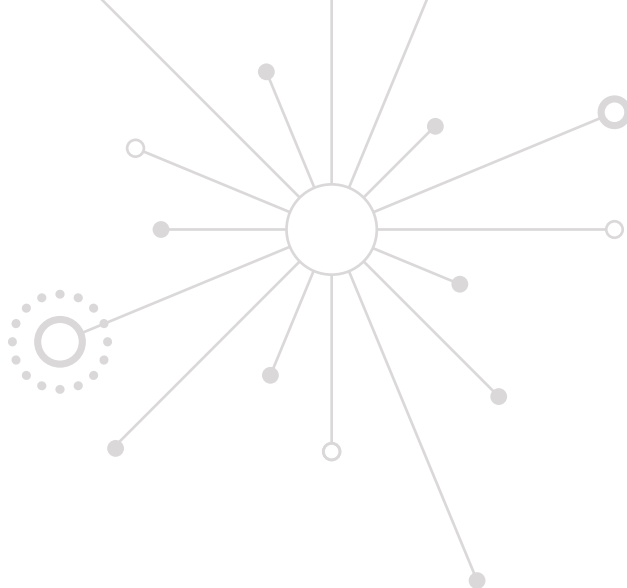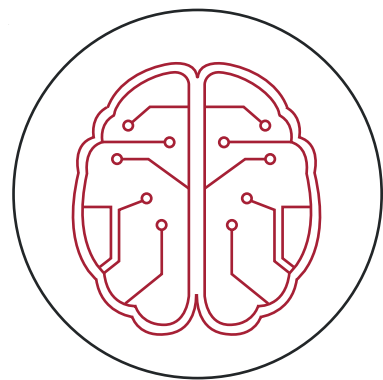
research that gets

INSIDE YOUR HEAD

BY MEGAN ALT

YOUR BRAIN HOLDS A LOT OF DATA—AND NOT JUST TRIVIA AND MEMORIES. BY SIFTING THROUGH HUNDREDS OF THOUSANDS OF BRAIN IMAGES, EYE SCANS, AND HEART RATE TESTS, THE NEUROSCIENTISTS IN THE CENTER FOR NEURAL DECISION MAKING (CNDM) USE THE BODY'S PHYSIOLOGICAL RESPONSES TO UNDERSTAND HOW WE MAKE DECISIONS.

The Center, founded by Angelika Dimoka, associate professor in the Department of Marketing, is the first neuroscience center located within a business school. It aims to provide a more objective understanding of the driving forces of a subject's decision making. In the past, researchers have had to rely on self-reported data, asking consumers why they choose this product or made that decision. This, however, left room for error, as perhaps the consumer could not—or would not—divulge the true reason for their decision.

Today, with state-of-the-art tools like eye tracking machines, heart rate monitors, and fMRI scanners, CNDM's research eliminates the subjective bias of decision-making research.

"We don't have to ask the subject anymore," says Dimoka. "We can observe their physiological state."

Dimoka and her colleagues, Vinod Venkatraman and Crystal Reeck, associate and assistant professors of marketing, use these tools to study the body's responses in experiments like the ability to recall print ads versus digital ads.

"With eye trackers, we can observe where the subject is looking at any given point," says Dimoka, allowing the researcher to understand exactly what information the subject is taking in at what time. Heart rate monitors, skin conductors, and breathing monitors analyze the person's emotional state—whether you sweat more, breath heavier, or have a faster heartbeat when making a decision.

Angelika Dimoka, Vinod Venkatraman and Crystal Reeck

+ WHAT THE BRAIN REVEALS

The Center also has a new functional magnetic resonance imaging (fMRI) machine, brought to campus this fall in partnership with the College of Liberal Arts' Department of Psychology and with support from the National Science Foundation. "The fMRI scanners show us the brain's functionality," Dimoka says. "We can put people in the scanner and observe how their brains function when they make decisions."

The areas of the brain that activate during different activities can reveal how consumers take in information and make decisions. As the fMRI machines take a picture every two seconds, the neuroscientists can see changes in blood flow within the brain. "When parts of your brain are working, they need oxygen," says Reeck, associate director at the Center. "So in the seconds after something happens in the experiment, we look for the blood flow changes."

Consider what happens when a person looks at a physical advertisement versus a digital advertisement. In a series of experiments funded by the Office of the Inspector General at the U.S. Postal Service, Dimoka and her colleagues studied subjects' brains as they reviewed ads in both print and online formats.

"The area of the brain associated with memory, the hippocampus, showed higher levels of activation for ads that subjects had seen before in a physical format as opposed to digital ads," says Dimoka. By using the brain scanning tools, the researchers found that print is still sticky, even in today's digital age.

The third phase of the experiments are currently underway. Dimoka says this new round will further investigate generational differences and brand awareness.

Are there any differences between the purchasing decisions of Millennials and Baby Boomers when looking at online versus print ads? "We did find some preliminary results [from earlier experiments] that were quite interesting," Dimoka says, "and the opposite of what you would expect." The full results will be published later this summer.

+ REAL-WORLD IMPACT

The Center investigates all kinds of decision making—including consumer, financial, and privacy decisions—that can have real impact on average people and companies. The impact of their work extends from marketing to fields like management information systems and finance.

For example, Reeck is currently working on a study that involves how people disclose private information. When signing up for Facebook or giving Amazon access to credit cards and addresses, users are sharing their data because there is something they want, like connection to friends or one-click shipping. "The hope is that if we understand a bit better that privacy calculus, the way that they're weighing the cost against the benefit," says Reeck, "we'll be able to then help people make choices that are more consistent with their own privacy preferences."

Companies are also affected by the Center's work. "By looking at the brain of how 30 subjects were responding," says Dimoka, "we can predict how millions of consumers in the United States would decide."

"That's the magic, the power of these tools."

"BY LOOKING AT THE BRAIN OF HOW 30 SUBJECTS WERE RESPONDING," SAYS DIMOKA, "WE CAN PREDICT HOW MILLIONS OF CONSUMERS IN THE UNITED STATES WOULD DECIDE."

what happens if work

FOLLOWS YOU HOME

BY MEGAN ALT

For many, work and personal time have begun to blur together as smartphones and emails have invaded the home. As this line erodes between the home and office, employees are often left unaware that their employers can glean so much information from their personal lives. "Most of us have left enormous data trails," says Eisenstadt, "that employers are now beginning to access in order to create the most efficient workplaces possible."

With social media, FitBits, and online healthcare platforms, Eisenstadt says, employers are gathering data from more than just workplace activities. Healthcare service platforms, for example, can tell by looking at internet searches, prescriptions changes, or specialist appointments that employees are planning to start a family or have major surgery.

The platforms indicate that only top-level numbers are shared with employers, not individual names of employees. However, she argues, "that knowledge could lead to companies making decisions about promotions, hiring, and terminations based on this information." Narrowing down gender and age, for example, could give employers enough clues to know which of their employees were likely to be trying to have a baby soon.

In her paper, "Data Analytics and the Erosion of the Work/Non-Work Divide," which was accepted for publication by the *American Business Law Journal*, Eisenstadt asserts that the current legal statutes do not provide enough protection to both employers and employees. "Laws like HIPAA and the Pregnancy Discrimination Act likely do not apply to data gleaned from search queries," she says. And there are virtually no laws or regulations prohibiting employers from collecting and relying on data gleaned from employees' social media profiles, from facial recognition software, or from Fitbits.
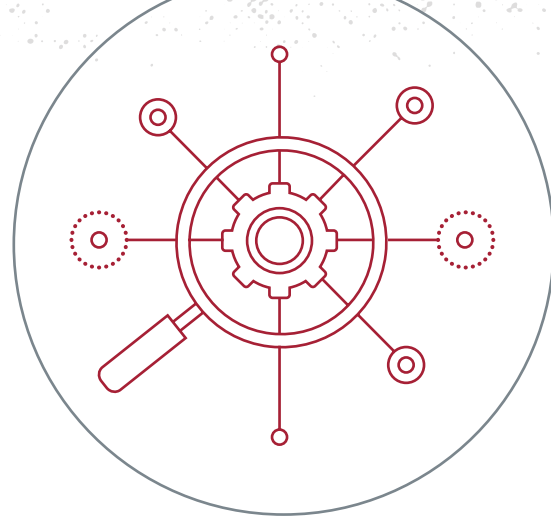
So why should employers care about overreaches into employee privacy?

"THE EROSION OF THE WORK/NON-WORK DIVIDE WILL IMPACT THE CONCEPT OF A 'SCOPE OF EMPLOYMENT' AND EMPLOYER ATTEMPTS TO AVOID LIABILITY FOR THEIR WORKERS' ACTIONS."

"The erosion of the work/non-work divide will impact the concept of a 'scope of employment' and employer attempts to avoid liability for their workers' actions," says Eisenstadt. Over the years, courts have seen the line blur between personal and work-related activities—like a case in 1928 in which an auto sales manager crashed a car, killing an employee on the way home from a staff appreciation dinner. The courts found the company liable for the death, and considered the events to be "within the scope of employment." This move toward an expanding "scope of employment" has only grown with the advent of laptop computers, smartphones, and the myriad other devices and technologies that make it easier and sometimes even essential to bring work outside of the traditional physical boundaries of the workplace.

By gathering data from nonwork activities, Eisenstadt cautions that employers may be pushing this trend to new, more troubling places. By eroding the work/non-work divide so dramatically, companies may be opening themselves up to new liabilities for employee health issues, violent outbursts, or other employee behavior that would previously have been considered to be outside the "scope of employment."

Data analytics can be an extremely powerful tool. "It allows humans to capture, analyze, and use massive quantities of data," says Eisenstadt, "that the human brain can not make sense of on its own." Yet, in today's environment of data concerns and privacy breaches, Eisenstadt warns, companies should be cautious of data mining that goes too far.

DATA-DRIVEN DECISION-MAKING IS NOW THE NORM IN MANY WORKPLACES. FIRMS COLLECT AND ANALYZE INFORMATION TO INFORM HIRING PRACTICES, PROMOTIONS, AND INSURANCE PREMIUMS. HOWEVER, LEORA EISENSTADT, ASSISTANT PROFESSOR OF LEGAL STUDIES AT THE FOX SCHOOL, WARNS THAT THE KINDS OF DATA THAT EMPLOYERS CAN TRACK SHOULD BE SAFEGUARDED BY LAW, TO BOTH PROTECT EMPLOYEES' PRIVACY AND LIMIT EMPLOYERS' LIABILITY.

translating research into

REAL IMPACT

Research deserves to be shared. For decades, business schools have been discussing the problem of translating the insights of academic research into more practical applications in industry. Many challenges common to the discipline—from language barriers and relevant questions, to academic infrastructure and misaligned incentives—can keep research from impacting industry and society.

In 2018, the Fox School took steps to address these barriers head-on to truly move the needle of impact—and change the way research is conducted, measured, and applied in business schools—by launching the Translational Research Center. Led by Executive Director Charles Dhanaraj, the Center demonstrates the Fox School's commitment and willingness to push the limits and explore the next frontiers in business education and research.

The Translational Research Center has already begun addressing these challenges. Recently, the center outlined potential challenges and paths forward based on discussions with over 150 researchers and editors of academic journals; produced short videos recapping specific questions from the summit; and hosted a case-writing consortium and pedagogy research workshop for tenure- and non-tenure-track faculty.

Dhanaraj and the Fox School have big plans for the future, including a council of business leaders to provide early feedback to research ideas, networking events between academics and industry executives, and strong engagement through the school's Executive Doctorate in Business Administration (DBA) program and its growing alumni base.

"The shift toward impact is a significant one, but it will take time," said Dhanaraj. "There are multiple stakeholders in the game. We will need everyone to make this happen. We do not have a choice."

TEMPLE UNIVERSITY

Temple is a top-ranked research university. A leader in education, science, healthcare and the arts, we are the powerhouse that charges the Philadelphia region.

FOX SCHOOL OF BUSINESS

Established in 1918 and celebrating its centennial, the Fox School of Business at Temple University is the largest, most comprehensive business school in the Philadelphia region and among the largest in the world, with more than 9,000 students, more than 220 full-time faculty and more than 60,000 alumni around the globe.

The Fox School has a proud tradition of delivering innovative, entrepreneurial programs for the past 100 years. With facilities that provide access to market-leading technologies, the school fosters a collaborative and creative learning environment. Coupled with its leading student services, the Fox School ensures that its graduates are fully prepared to enter the real-world job market.

OFFICE OF RESEARCH, DOCTORAL PROGRAMS, AND STRATEGIC INITIATIVES

The Office of Research, Doctoral Programs, and Strategic Initiatives strives to enhance the reputation of the Fox School of Business and School of Sport, Tourism and Hospitality Management at Temple University as global leaders in business research and community engagement to better serve our constituents—students, faculty, academia, industry, and society in general.

RESEARCH WITH IMPACT

Between 2015 and 2017, Fox and STHM faculty published

185

articles in top-tier academic journals, received

16,000

citations on Web of Science, and collected

117,000

new downloads on the Social Science Research Network in

109

countries. Faculty received

32

new sponsored projects, totaling nearly

$4.5 MILLION

in grant funding.

fox.temple.edu/research

Fox School of Business

1810 Liacouras Walk
Suite 412
Philadelphia, PA 19122-6083

SHAPING THE FUTURE OF RESEARCH

For more than a century, we have been a leader in producing thinkers, doers, and trailblazers. Our research has far-reaching effects, from advancing academic literature to changing business industries. Learn more at fox.temple.edu/research

FOX.TEMPLE.EDU/RESEARCH

FOX 100 YEARS
SCHOOL OF BUSINESS
TEMPLE UNIVERSITY

Sustainably designed and printed to reflect Temple University's commitment to environmental stewardship.