



INSTITUTE OF  
INTERNATIONAL  
FINANCE

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# **DIGITIZING INTELLIGENCE: AI, ROBOTS AND THE FUTURE OF FINANCE**

# Digitizing Intelligence: AI, Robots and the Future of Finance

## INTRODUCTION

Collapsing costs in computing, geometric growth in data, and intense competition between deep-pocketed companies have begun delivering breakthroughs in artificial intelligence (AI). Within financial services, AI technology could allow companies to establish new business models, reduce risk and expense, and increase productivity. It could also enable both large and small firms to offer financial services at a level of sophistication, customization and scale never previously possible. While the potential benefits of the innovation are substantial, a growing number of concerns are emerging too, ranging from accountability and privacy issues to the automation of white-collar jobs and even existential threats as cautioned by a growing number of prominent scientists and thinkers. This paper will examine the current and near-term applications of AI in finance and the potential concerns, risks, and opportunities surrounding the technology for the industry.

## WHAT IS AI?

AI enables software to exhibit human-like intelligence, including learning, planning, reasoning, problem-solving, and decision-making<sup>1</sup>. AI has existed as a field since the 1950s, when a group of scientists convened at Dartmouth College to explore "how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves." While the field has advanced in fits and starts since, numerous basic artificial intelligence tools exist today, including virtual assistants Siri (Apple) and Cortana (Microsoft), Google Translate, and Netflix's viewing recommendation engine. Other applications are emerging too, such as self-driving cars, autonomous trading platforms, and emotion-reading humanoid robots. Much of today's technology is "weak" or "narrow" AI, whereby a software focuses on one narrow task—a machine that can beat a human chess master but cannot play a game of tic-tac-toe, for example. But efforts continue to advance toward Artificial General Intelligence—a computer that is as smart as a human across the board—or even Artificial Superintelligence—a computer that is much smarter than the greatest human minds in every field. These advanced generations could conceive of original and creative concepts, engage in a coherent discussion on a wide range of topics, and perhaps even display an awareness of their existence and place in the world. And while more advanced forms of AI are by no means inevitable, this last decade has seen a number of tangible breakthroughs in the field, including IBM Watson's 2011 defeat of two former champions on the TV quiz-show *Jeopardy!* and Google DeepMind's defeat of a top human player at the 2,500-year-old game of [Go](#). Facilitated by increases in computing power and the advent of big data, AI is attracting increased attention as the technology quickly becomes proficient at performing tasks that have historically been difficult for computers to execute, including recognizing images, identifying spoken word, and using unstructured, or unlabeled, data.

Learn more about artificial intelligence in finance at the IIF's Spring Membership Meeting in Madrid, May 24 and 25, which will feature a panel of leading AI experts, including Shamil Chandaria, Advisor, Google DeepMind; Daniel Nadler, Founder & CEO, Kensho; and Gurjeet Singh, Co-Founder & CEO, Ayasdi. For more information on fintech sessions at the event and how to register, please click [here](#).

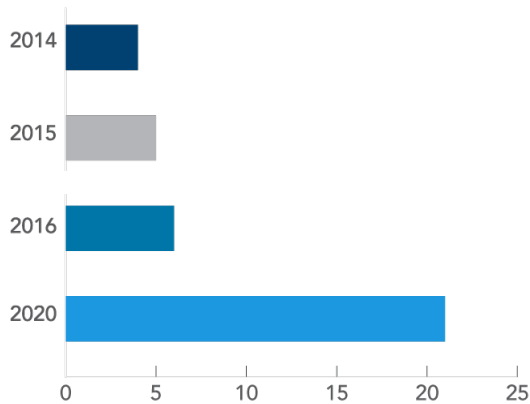
<sup>1</sup>Artificial intelligence is a broad field with many sub-fields and related fields, including "machine learning," "deep learning," and "cognitive computing." For purposes of the paper, we have included examples of different forms of AI and machine learning without distinction. For more explanation, please click [here](#).

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## BIG DATA

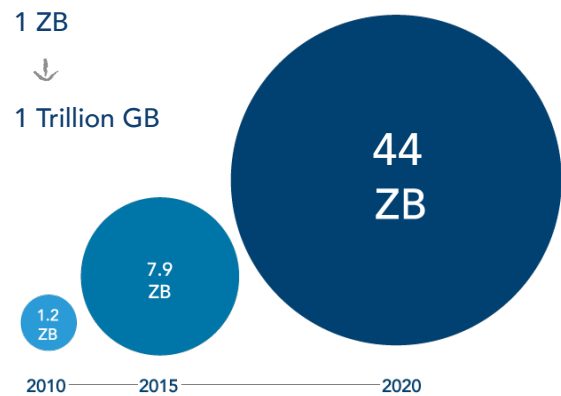
The field of AI has developed symbiotically with the explosion of big data. According to International Data Corporation, a technology market-intelligence firm, the digital universe is doubling in size every two years. This dramatic growth is attributable to a variety of factors, including new storage solutions and Internet-connected devices (Chart 1).

CHART 1  
Internet-Connected Devices  
installed units, billion



Source: Gartner.

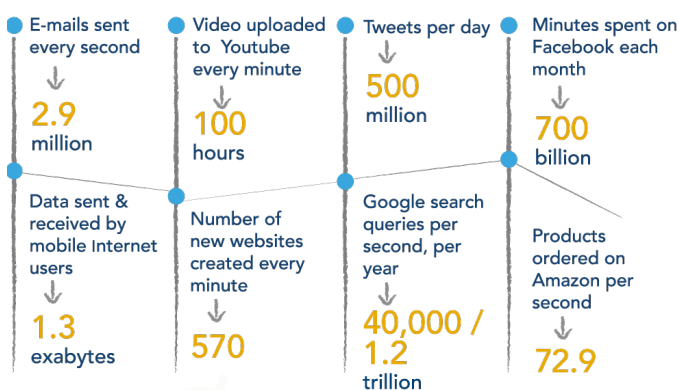
CHART 2  
Growth of Global Data  
zettabyte



Source: CSC and IDC.

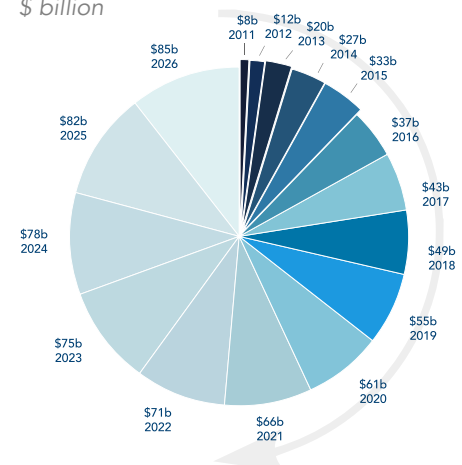
The explosion of data (Chart 2 & 3) has coincided with a decline in the cost of collecting and processing digital information, as well as a substantial rise in computing power. This in turn has helped data mining become more affordable resulting in the fast expansion of the big data industry, which is expected to grow to \$84.69 billion by 2026 up from \$7.6 billion in 2011 (Chart 4).

CHART 3  
The World of Data



Source: KPMG, Forbes, Big Data.

CHART 4  
Big Data Market Forecast  
\$ billion



Source: Wikibon.



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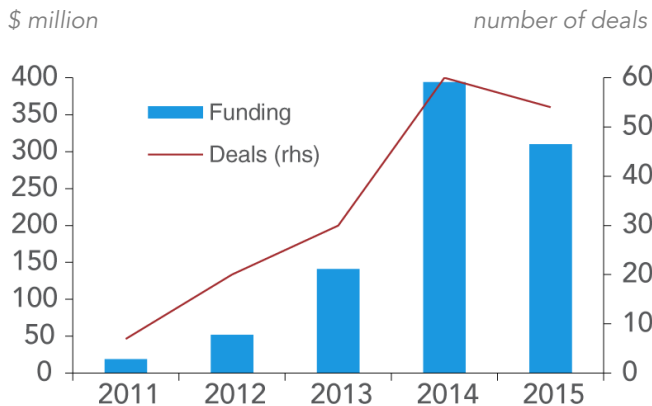
Big data helps AI software to learn by enabling AI systems to examine new information and evaluate it with existing data to search for patterns and connections. Each time the computer performs the process, it expands its capacity to classify information, generate forecasts, and perform analysis, resulting in increasingly superior decision-making.

The symbiotic relationship between AI and big data will have a transformative effect on financial services in the coming years and decades. This realization has led to an increase in activity in the space as companies position themselves to take advantage of the coming age of automation and artificial intelligence. The following sections will explore this growing activity and the emerging use cases of AI technology in the finance industry.

## AI ACTIVITY AND APPLICATIONS

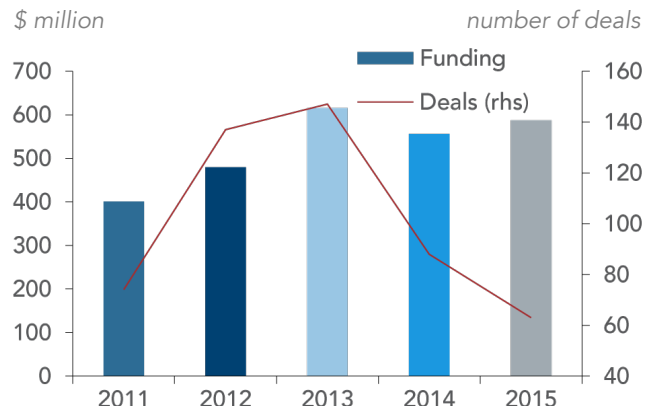
According to CB Insights, a U.S.-based research firm, AI startup financing activity has grown at a CAGR of 100% between 2011 and 2015 (Chart 5). Financing activity in the overall AI industry has risen at a slower, but respectable, 10% CAGR over the same period (Chart 6). IBM, which has committed \$1 billion to its AI division, the Watson Group, has played a key role in the development of the technology. Other important companies heavily invested in the space include tech titans such as Amazon, Facebook, Google, and Samsung.

CHART 5  
AI Startup Financing Activity  
\$ million



Source: CB Insights.

CHART 6  
Overall AI Financing Activity  
\$ million



Source: CB Insights.

Finance firms have also been investing in the space and are positioning themselves to leverage the technology. In November 2014, Goldman Sachs led a \$15 million investment round in [Kensho](#), a data analytics company utilizing machine learning algorithms, and partnered with the company to apply its "real-time statistical computing and analytics" technology across the investment bank. In 2015, Charles Schwab launched Schwab Intelligent Portfolios, a robo-advising service utilizing AI techniques, and Bridgewater, the largest hedge-fund manager in the world, established an AI team.

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Moreover, Two Sigma and Renaissance Technologies, two New York-based investment firms, are increasingly recruiting computer scientists to expand their AI capabilities. This influx of capital and interest in the space is attributable to the growing list of applications of the technology, including reporting, advising, and alerting.

## Reporting

AI software has made significant strides towards generating natural language reports. Today's technology is capable of bridging gaps between the data that computers require for analysis and the language-based communication that people require to grasp that analysis. An example of a company that is automating the writing of reports is Chicago-based [Narrative Science](#). According to the firm's website, "We are helping companies operationalize data storytelling with Quill, our advanced natural language generation (NLG) platform. By automatically transforming data into narratives, our artificial intelligence software dramatically reduces the time and energy people spend analyzing, interpreting and explaining data...The result is a narrative indistinguishable from what a human would write." Going forward, Quill, and platforms like it, could help reduce the significant resources financial organizations use to report on client investment strategies, regulatory compliance, fraud, portfolio performances, or economic outlook. Narrative Science's software is already being utilized by several established companies, including Forbes, an American business magazine, to cover rudimentary financial stories, and Credit Suisse to "improve investment research coverage, quality and consistency." Another firm offering similar AI solutions is France-based [Yseop](#), which uses natural language software to respond to queries. The software is able to write responses in English, French, German, and Spanish at 3,000 pages a second.

## Advising Institutional Investors

The significant progress in AI software has sparked massive interest in the technology from the investment industry for its advisory potential. A common view shared by many analysts in the industry is that a sophisticated trading machine capable of learning and thinking will make even today's most advanced and complex investment algorithms look primitive. Some are even of the opinion that many of today's fund manager positions will become redundant in the not-too-distant future. According to David Siegel, co-chairman of Two Sigma, "The challenge facing the investment world is that the human mind has not become any better than it was 100 years ago, and it's very hard for someone using traditional methods to juggle all the information of the global economy in their head. Eventually the time will come that no human investment manager will be able to beat the computer."

AI software is already allowing companies to evaluate deals, investments, and strategy in a fraction of the time it takes today's quantitative analysts, or quants, who build complex—but also somewhat static—models in Excel. Quants can produce several effective models per week. AI machines can construct thousands. According to Yin Luo, managing director and global head of quantitative strategy at Deutsche Bank Securities, "It's a very promising area. Artificial intelligence can help you find patterns a human would never see. That can give you a huge edge." He and his colleagues have created an AI-based algorithm that autonomously searches market data for valuable trading opportunities.

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IBM has been playing a key role in discovering ways for financial firms—including Australia-based ANZ, U.S.-based Citigroup, and Singapore-based DBS Bank—to advise their clients using AI technology. ANZ Global Wealth, for instance, has been working with IBM's Watson Engagement Advisor since 2013 to better serve their 2.4 million clients and management of approximately \$65 billion in investment and retirement savings. Mike Adler, global financial services leader at IBM Watson, told Markets Media, a U.S.-based firm focused on investment news, that the Melbourne-based wealth management company utilizes Watson's services at one of its call centers "to observe the types of questions coming from both customers and financial advisors, helping enable its financial advice team to deliver an improved advice process, ultimately delivering faster, more personalized financial recommendations to customers... Watson's ability to uncover new insights means cognitive computing has the opportunity to change the way wealth managers and financial service providers make decisions and counsel their clients."

Smaller software-based companies have been active in the area as well. Silicon Valley-based [Addepar](#), whose clients represent over \$300 billion collectively, has begun making waves in investment management. The industry, according to the firm's CEO, Eric Poirier, "is still powered primarily by people with spreadsheets and other decades-old tools, making it impossible to keep current in this increasingly complex and rapidly evolving world." The company has responded by building technology that provides "comprehensive data aggregation, powerful analytics, and customizable communication tools" to wealth managers, giving them real-time insights into investments and financial markets. Addepar's integrated platform, which uses machine learning and predictive techniques, allows wealth managers to replace the suite of software tools many of them currently use and become more productive and better advisors to their clients.

Moreover, [Sentient Technologies](#), a San Francisco-based AI firm backed by \$144 million in funding, utilizes advanced machine learning to turn big data into smart data and execute algorithmic trades on the stock market. Babak Hodjat, Sentient co-founder and chief scientist, told Wired magazine that the system "automatically authors a strategy, and it gives us commands. It says: 'Buy this much now, with this instrument, using this particular order type.' It also tells us when to exit, reduce exposure, and that kind of stuff." The company has worked with Highbridge Capital Management, an alternative investment management firm owned by JPMorgan Chase, in applying AI technology to trading, according to a report by Bloomberg.

Furthermore, Kensho is developing AI software to advise traders, investors, and analysts. Founder and CEO Daniel Nadler told the IIF, "Human history has never seen a period when so much data, about every aspect of the world is available, essentially instantaneously and free. That coincides with the ability of machines to acquire and synthesize data, also essentially for free. The game for investors now transforms, from 'who has the best answers?', to 'who can ask the best questions?'" Users of Kensho's platform are able to ask complex questions in natural language such as "What sectors and industries perform the best three months before and after a rate hike?" and "What happens to U.S. homebuilder stocks if a category four hurricane makes landfall in Florida?" After scanning a mountain of data, the platform responds to the question, also in natural language, within seconds.

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"The human mind has many strengths, but ultimately lacks the memory, calculation capability and breadth of information integration to keep up with AI systems in the context of analyzing, understanding and predicting modern financial markets."

- BENJAMIN GOERTZEL, CHAIRMAN  
AND CHIEF SCIENCE OFFICER,  
AIDYIA

The cloud-based software can retrieve answers to more than 65 million query combinations by analyzing more than 90,000 actions such as company earnings reports, political events, economic data, policy changes, and their effect on virtually every financial asset worldwide. According to Mr. Nadler, "This essentially gives you a quant army."

Finally, [Aidyia](#), a Hong Kong-based asset management firm, recently launched a fund that independently identifies and executes all stock trades using multiple forms of AI. The automated system predicts price changes based on a host of data, including market prices and volumes, information provided by multilingual social media and news outlets, corporate balance sheets and macroeconomic records. According to a 2015 Bloomberg [interview](#) with Ken Cooper, the company's CEO, Aidyia performed an 11-year backtest with data from 2003 to 2014 and saw annual returns in excess of 25%. Over the next five to ten years, Aidyia sees more and more of the world's funds being managed by intelligent machines rather than quantitative software. "The human

mind has many strengths, but ultimately lacks the memory, calculation capability and breadth of information integration to keep up with AI systems in the context of analyzing, understanding and predicting modern financial markets," according to Benjamin Goertzel, the company's chairman and chief science officer.

## Corporate Decision-Making

In one of the most interesting applications of AI technology, Hong Kong-based [Deep Knowledge Ventures](#), a venture capital firm focused on life science companies, appointed a machine learning program to its board of directors in 2014. The program, VITAL (Validating Investment Tool for Advancing Life Sciences), which was developed by UK research agency Aging Analytics, provides investment advice to the board by evaluating financing activity in databases of firms in the niche field.

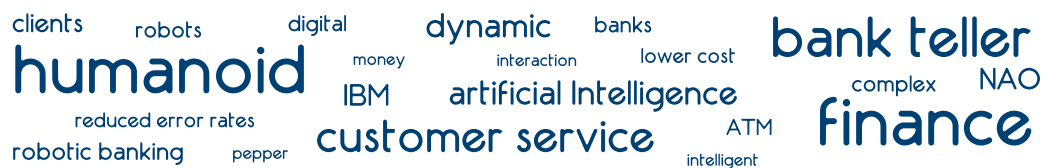
IBM is currently developing a comparable tool—the Watson Cognitive Environment—which would enhance company meetings of the future by enabling "human-computer collaboration at the speed of thought." This "Cognitive Boardroom" would empower employees to interact with the digital world in a dynamic and seamless manner during meetings to develop, for instance, a corporate strategy. The system would be capable of recording the meeting and putting it into text, audio, and visual format, displaying solutions and answers to simple and complex questions on a large screen, and also producing its own advice and guidance consistent with corporate strategy based on big data analytics and intelligent algorithms. For example, the cognitive environment could provide meeting executives with quick and detailed analysis on potential targets for a merger or acquisition.

Such digital environments could help companies improve decision-making processes, produce corporate strategy at lower cost, and transform management styles. Not only would such tools increase the speed at which company decisions could be made but it would also reduce error rates and human biases based on emotion and irrational and imperfect knowledge in the decision-making process.

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## Robotic Bankers

AI is facilitating the rise of robots in finance. For example, the Bank of Tokyo-Mitsubishi UFJ introduced its first humanoid robot, NAO, in Tokyo in 2014. The 58-centimeter (23-inch) machine can speak nearly 20 languages and read human emotions. The customer service robot welcomes bank clients into the branch, "Hello and welcome. I can tell you about money exchange, ATMs, opening a bank account, or overseas remittance. Which one would you like?" NAO analyzes behavior and facial cues to deliver situation-appropriate responses to client queries. When necessary, NAO, which can recall details from over five million clients and more than 100 financial products, is able to direct individuals to the appropriate bank employee based on the interaction and goals of the customer. Similarly, Mizuho Bank introduced its own customer-facing robot, Pepper, the same year to perform comparable tasks. Pepper, approximately twice the size of NAO, continually evolves and improves its abilities by connecting to thousands of other Peppers through the cloud and interacting with clients.



While their capabilities are still rudimentary, these two humanoid robot models are leading the way for AI robotics in the finance industry. Today, NAO and Pepper contribute to the functioning of the banks by welcoming clients and responding to queries in multiple languages. This provides bank employees with additional time to address more complex assignments. It is entirely conceivable that in the not-too-distant future, advanced intelligent humanoid robotic assistants work ever-more closely with humans on a number of wide-ranging tasks and provide more value-added services.

## Personal Financial Management

AI systems are also facilitating personal financial management. An example of this is the "smart wallet," a mobile application that evaluates an individual's financial profile and spending and saving activity to deliver real-time and on-location advice to clients based on a "conceptual awareness" of their personal financial needs and objectives. An example of a company developing smart wallet services is San Francisco-based [wallet.AI](#), which, according to CEO, Omar Green, "builds machines to help consumers make smarter decisions about their money, especially when they're out spending it." Such an AI-based app could, for instance, warn against spending money at an expensive restaurant when similar cheaper meal options were available nearby or warn how buying that new suit may make it difficult to pay rent at the end of the month. This granular level of service could never be duplicated by a human advisor due to the small scale financial decision-making involved.

Another example of AI being used for personal financial management is the new category of virtual banking specialists. There are several companies exploring this space and significant progress has been made. For example, NYC and Silicon Valley-based [Kasisto](#) created a deep learning conversation AI platform that "augments mobile financial applications by enabling intelligent conversations using the perfect mix of speech, text and touch interfaces."



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Kasisto's virtual banking specialists allow consumers to understand their spending patterns in real time, such as "How much did I spend at Starbucks this month?", and execute complex transactions on the go, such as "Make a payment on my AmEx today, and pay \$235 from my savings account." According to Zor Gorelov, CEO and co-founder of Kasisto, "Our products are designed to simplify the banking experience for consumers, provide a richer set of features, and, more importantly, make banking ubiquitous."

[IPsoft's](#) "learning cognitive agent," Amelia, is another example of what could become a widespread virtual banking assistant in the near future. The software can absorb vast amounts of knowledge, understands concepts, measures emotions, learns independently, and is able to assist customers with a wide range of services, including opening accounts. The tech company's chief cognitive officer, Edwin Van Bommel, also told us that she is able to resolve issues 50% faster than a human in a similar customer service situation. Amelia communicates via online chat and utilizes contextual filters to allow her to understand questions structured differently but with the same meaning. If she is unable to answer a question, she will refer the customer to a human colleague for help, listen to the conversation, learn the answer, and then be prepared the next time she is asked that question. Amelia is currently being tested by several multinationals, and Mr. Van Bommel says she will go live later this year.

Large financial firms are actively pursuing virtual banking assistant capabilities too. USAA—a diversified financial services group of companies that provides insurance, investing and banking services and products to current and former members of the United States military and their families—is using AI technology to improve navigation features on its mobile app and enable its clients to perform 200 transactions through voice commands, including paying bills and transferring money. Furthermore, Barclays announced that it would pursue similar technology so that its customers could bank with the help of a digital assistant. "We're very soon going to be entering a world where we may not have to be physically touching a device in order to execute transactions or to be able to engage with computers," Derek White, then chief design and digital officer at Barclays, told CNBC in an interview at London Technology Week last year.

The introduction of personalized cognitive assistants will have significant ramifications for the industry. The enormous amount of real-time data that financial firms will be able to collect through the software-human banking relationship will allow them to gain deep insights into each of their clients' unique needs, and provide customized products and services accordingly. Moreover, firms utilizing cognitive agents will reduce operational costs as the need for employees performing similar tasks gradually vanishes.

### **Regtech**

Since the 2008 financial crisis, many financial firms have spent a significant portion of their budget on enhancing their colossal regulatory and compliance systems. Financial incumbents have hired thousands of people and spent billions of dollars to ensure that they comply with the new comprehensive rule sets, including the European Market Infrastructure Regulation (EMIR) in the EU and the Dodd-Frank Wall Street Reform and Consumer Protection Act in the United States; provisions against insider trading, collusion, terrorist financing, and money laundering; as well as initiatives such as Know Your Customer (KYC) and the Foreign Account Tax Compliance Act (FATCA).

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Lucid's platform, Cyc, uses AI to crosscheck real-time activity of each department within a company with up-to-date financial regulations across all applicable jurisdictions to quickly identify any compliance violations.

For example, in a 2014 letter to shareholders, JPMorgan Chase said that it added 13,000 employees from 2012-14 to support regulatory, compliance and control efforts, at a cost of \$2 billion. In the same years, it spent a combined \$600 million on regulatory and control technology. Deutsche Bank spent an additional €1.3 billion on new regulatory requirements in 2014 and UBS spent \$946 million on regulatory demands the same year, almost half of which was permanent cost. Finally, Deloitte estimates that the European insurance industry spent between \$5.7 and \$6.6 billion in 2012 to comply with new regulations and that Solvency II-related costs amounted to 58% of this spending.

It therefore comes as no surprise that many financial firms are urgently seeking technological solutions to address regulatory and compliance costs more efficiently and effectively, what we refer to as "regtech." Because the work performed around compliance is frequently repetitive with enormous amounts of information, it is ideal for AI-based solutions. For instance, intelligent software could monitor data entry tasks and over time learn how to ensure that all data entries going forward are accurate and also how to measure risk, detect illegal activity, and test for specific events. According to hundreds of technology experts surveyed by the World Economic Forum in 2015, 75% believe that 30% of corporate audits will be performed by AI by 2025. Already, machine learning algorithms are effectively uncovering irregular activity and natural language processing (NLP) software is exposing subtle signs of suspicious behavior in transactions unnoticeable in numbers, only in text. And while NLP technology is still nascent, it is already ameliorating companies' capacity to identify and address problems at scale.

U.S.-based [Lucid](#) and [Feedzai](#) are two examples of firms developing AI software to help with compliance. Lucid's platform, Cyc, uses AI to crosscheck real-time activity of each department within a company with up-to-date financial regulations across all applicable jurisdictions to quickly identify any compliance violations. Feedzai uses machine learning models to uncover fraud up to 30% earlier than conventional techniques. Moreover, Feedzai's machine learning models "detect up to 80% of fraudulent activity—two-thirds more than traditional systems," according to a white paper published by the company.

Eric Crittenden, portfolio manager and CIO at Longboard Asset Management, told Markets Media, "Research efforts in compliance are usually behind the curve because compliance is not a profit center, but there is a lot of value that can be added by mining the data and setting up intelligent queries and algorithms to go out and look for red flags...over time you'll see compliance become more effective and more efficient from the use of synthetic intelligence." Going forward we are likely to see increasingly more AI solutions related to compliance as firms look to control costs in the new heavily-regulated environment.

## Other Applications

There are many other areas within finance where AI technology can be leveraged. For instance, several alternative lending companies, including [Kabbage](#), [Lending Club](#), and [ZestFinance](#), use machine learning software to create credit risk models and predict bad loans. Many observers believe AI will lead to creditors making better lending decisions, more efficient loan underwriting and pricing, and billions of dollars in savings for both lenders and borrowers.

Furthermore, advances in real-time translation of spoken language will likely play a role in improving the ability of multinational finance companies to communicate with international clientele, business partners and other parties around the globe. While far from perfect, the technology is improving rapidly and will likely limit the need for financial firms to hire professional translators and multilingual customer service representatives going forward, especially when the technology is combined with virtual cognitive assistants. In addition, AI systems could transform the insurance industry by helping firms automate the underwriting process and facilitating better decision-making through the utilization of more detailed information. For example, data collected from biometric sensors and medical files could be pulled together by AI systems to provide insurance companies with valuable and up-to-date information regarding the health of their customers. Some observers are of the opinion that insurance companies would even pay for their clients' biometric sensors as it would allow them to assist customers in living healthier and longer lives and thus collect more premiums over the life of the policyholder. Moreover, machine learning software could facilitate claims processing automation and in doing so reduce the time it takes to process a claim from weeks, or even months, to just a couple of minutes.

Finally, organizations are deploying AI technology for cybersecurity. [Neokami](#), a Munich-based AI company, is one of the leaders in the space. According to the firm's website, it has developed a platform that is "optimized to solve a focused set of today's pressing data security problems." Neokami's platform has been used by many Fortune 500 Enterprises.

## CONCERNS MOVING FORWARD

The adoption of artificial intelligence technology by the finance industry will lead to growing regulatory, security, privacy, accountability and social concerns going forward. For instance, without appropriate security safeguards, criminals may figure out a way to successfully impersonate bank customers and convince AI systems to release other people's private and sensitive financial data, potentially resulting in devastating outcomes. Moreover, questions surrounding who will have access and control of the ever-growing non-sensitive consumer data that AI programs such as digital cognitive agents will be able to extract from their interactions with clients will need to be addressed. Other important considerations for policymakers include how to assess and audit companies that develop and operate AI software, how to regulate AI-powered financial advisors, and how to determine if an AI system failed or provided inappropriate advice, and if so, who would be liable?



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47% of U.S. jobs in 2010 were at a high risk to be replaced by a computer within one or two decades.

One area in particular that concerns regulators is trading as intelligent algorithms are set to play an increasingly important and central role in automating the process. This could intensify and quicken the disastrous effects of a trading glitch. The risks associated with increasing trade automation can be seen with the example of Knight Capital, an American market-making firm, which imploded in 2012 when its trading algorithm became infected causing it to buy high and sell low, leading to a \$440 million loss in less than an hour. Regulators worry that ultra-fast mechanized trading is making markets more delicate and that a glitch in one market can impact others at astonishing speeds, as per the findings of a 2015 [report](#) by the Bank of England. The chairman of the U.S. Commodity Futures

Trading Commission (CFTC), Timothy Massad, informed an industry conference last year that, "The speed and complexity of our markets can give rise to problems and create greater damage than when our markets were less sophisticated." As humans introduce increasingly complex and independent AI-based trading systems into the market, it is possible that two or more competing algorithms could destabilize or magnify one another, and in the process cause prices to erratically jump up or down at lightning speeds, causing panic to spread throughout global financial markets.

Moreover, social concerns will undoubtedly intensify as AI and related technologies evolve and begin threatening a widespread number of occupations across many industries with automation. According to a [study](#) released by Oxford University in 2013, 47% of U.S. jobs in 2010 were at a high risk to be replaced by a computer within one or two decades. Michael A. Osborne, one of the study's co-authors, told us that although certain high skill jobs that rely on social intelligence, creativity, and negotiation are immune to automation, at least in the foreseeable future, many white-collar positions in the finance industry, such as bank tellers, loan officers, mortgage brokers, insurance underwriters, accountants, and auditors, are at risk. While this is more of a long-term concern, policymakers will need to start focusing on the issue soon due to the potential of massive disruption.

Finally, a major worry for a growing number of observers that applies far beyond the world of finance is the possible existential threat posed by AI. Elon Musk, an entrepreneur and technologist, described artificial intelligence as "summoning the demon," and the creation of a machine intelligence rivaling the human brain as potentially one of the greatest threats confronting the world. Similar sentiments have been echoed by Stephen Hawking, the world's foremost physicist, and other prominent scientists, in an opinion article in the UK's *The Independent* in 2014 in which they suggest that dismissing the idea of ultra-intelligent machines as mere science fiction may turn out to be "potentially our worst mistake in history." Renowned thinkers like those mentioned above see the possibility of an "intelligence explosion" where an AI agent could improve upon itself continually at an exponential rate leading to a world where computers become more powerful than humans in every way imaginable. While this may seem like science fiction, there are many who fear that this is a very real possibility in the long term. Several organizations, including the [Centre for the Study of Existential Risk](#), the [Future of Humanity Institute](#), the [Future of Life Institute](#), and the [Machine Intelligence Research Institute](#), are addressing these concerns and working towards ensuring that smarter-than-human AI has a positive impact on the world.



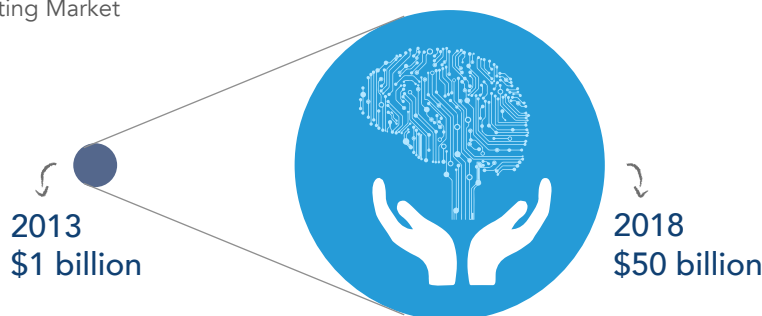
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Going forward, as the number of AI applications increases and the technology becomes further embedded into the economy, policymakers will need to address the aforementioned concerns, identify regulatory weaknesses, and advance effective laws to limit the potential risks associated with the quickly evolving innovation without impeding its beneficial progress. Moreover, it will become increasingly important for governments, the scientific community, and businesses to collaborate and foster appropriate policy throughout the evolution of artificial intelligence.

## CHALLENGES AND OPPORTUNITIES FOR FINANCE SECTOR

Artificial intelligence technology has experienced rapid progress in recent years thanks in large part to several deep-pocketed tech titans that view AI as an integral part of their business models. Companies such as Amazon, Apple, Baidu, Facebook, Google, and Microsoft have entered into what some call an AI arms race, competing for elite engineers, buying startups and establishing laboratories. Alibaba Group Holding, a Chinese e-commerce company, has also been actively exploring the space and revealed last year that it would invest heavily in the technology. The finance sector's growing interest and activity in AI is partially attributable to the potential threat posed by technology companies, many of which have massive amounts of customer data that offer valuable insights into their users. It is entirely plausible that tech firms would expand into broader financial services, leveraging their own technical expertise, innovative and integrated platforms, extensive customer data, loyalty among millennials, and lighter regulatory environment. Many financial incumbents understand this reality and are well aware that AI and its related technologies are a potential threat as well as an opportunity for their sector.

CHART 7  
U.S. Cognitive Computing Market  
\$ billion



Deloitte, 2013

Firms leveraging the technology will be better positioned to allocate resources more efficiently, provide customized and high-quality products and services to their clients, reduce errors and operational costs, automate complicated tasks, improve decision-making and the standardization of process workflow, increase profitability, and drive stronger growth and market expansion. In light of all these potential benefits, it comes as little surprise that in 2013 Deloitte forecast the cognitive computing market in the U.S. alone to expand from \$1 billion to \$50 billion by 2018 (Chart 7). This forecast is in line with what Neal Cross—managing director and chief innovation officer of DBS Bank—told the IIF in February, "We'll see significant impact of machine learning and cognitive computing in the next five years. It has the potential to be more impactful than blockchain."

# Digitizing Intelligence: AI, Robots and the Future of Finance

With the pace of technology adoption accelerating (Chart 8), innovation cycles contracting, and distribution rates rising across the world, it will prove beneficial for traditional financial firms to keep up with the changing AI landscape. Those firms that increasingly embrace AI and proactively build innovative, integrated and robust tools across multiple channels in order to provide customized products and services seamlessly to their clients will be in a much better position to overtake the competition, capitalize on emerging market opportunities and increase market share while simultaneously cutting operational costs.

CHART 8  
Time Taken to Reach 50 Million Users



Source: KPMG

## CONCLUSION

Driven by significant advances in technological capabilities, the explosion of big data, more powerful software, and low cost, scalable cloud computing, artificial intelligence appears to finally be at a real tipping point. In addition to a number of software-driven companies, several financial firms have now initiated strategic partnerships and investments in the space as they seek to position themselves to take advantage of the coming age of automation and AI, and gain a competitive advantage over rivals. The use of AI in financial services is likely to have an outsized impact on functions and employment as the automation of advanced roles becomes feasible. Going forward, technology-induced competition will force further innovation and an expansion of AI applications in use today. It remains unknown exactly how quickly the technology will evolve and just how sophisticated it will become, but with so many recent innovative breakthroughs, intense competition between deep-pocketed companies, massive social curiosity, and huge potential benefits, many observers—while recognizing the technology is still in its early days—believe AI is on its way to transform the finance industry, and the economy at large, in the coming years and decades. And though the warnings put forth by some prominent thinkers are most likely hyperbole, the evolution of artificial intelligence technology warrants serious oversight, planning, and control to minimize its risks and unwanted impacts.



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