Welcome to the Cognitive Era.  
A new era in technology, a new era in business.

For the past several years, the IT industry has been re-ordering, driven by simultaneous developments in data, analytics, cloud, mobile, social media, and the Internet of Things.

At IBM, we have been undertaking one of the most significant transformations in our history to lead these shifts and to help our clients take advantage of these new capabilities. In doing so, we have learned:

• While there are great benefits from applying the individual technologies, the greatest value comes from putting these capabilities together, in the context of an industry or profession.

• This is about business innovation, and it is a top priority for leaders everywhere—from CEOs to heads of state. You often hear them describe this as “becoming digital.”

• We’ve learned that “digital” is not the destination, but the foundation for a new era of business. We call it Cognitive Business and you will most readily recognize it in the form of Watson.

This white paper explains how Cognitive Business is taking shape, and its implications for the future of business and society.
Why is the Cognitive Era emerging now?

We are witnessing the convergence of three massive shifts at the intersection of technology and business:

1. **A world awash in data.** You know data is flowing from mobile devices, social networks, and every digitized and connected product, machine and infrastructure. Data is replacing guessing, approximations, and averages. We can know with greater precision what customers will want, where traffic will form, how the disease will progress, and where the risk is greatest.

Yet 80% of data has been essentially invisible to computers and, therefore, of limited use to us. That 80% includes everything humanity encodes in language — from textbooks and formulas, to literature and conversation — plus all that is captured in sight, sound, and motion. This “unstructured” data is skyrocketing and will be the majority of all the data in the world — which will reach 44 zettabytes by 2020.

Over the next two years:

- Healthcare data will grow 99%, and 88% of all healthcare data will be unstructured. It is coming from electronic medical records (EMRs), test results, medical images, video, patient sensors such as wearables, bedside devices and implants. Medical image archives alone are increasing by 20–40% annually.

- Government and education data will grow 94%, with 84% unstructured. It is coming from all manner of sensors and audio/video data from buildings, roads, vehicle fleets and utility assets, as well as student evaluations, tests, profiles and student/teacher records. US Geological Survey and NASA data exceeds 7.5 petabytes (equal to 100 years of HD video).

- Utilities industry data will grow 93%, and 84% of it is unstructured, coming from smart meters, sensors on assets, images, video and employee notes. It is estimated that 680 million smart meters will be installed globally by 2017 — leading to 280 petabytes of data a year.

- Media industry data will grow 97%, with 82% being unstructured. It is coming from books, journals, newspapers and other publications, as well as video, film, audio recordings and online gaming. Every month, 27.5 petabytes of Internet video data are generated.

This is a vast, expanding and potentially priceless resource, but one out of reach of our systems. Until now.

2. **The re-invention of the world in code.** The world is being “rewritten” in software code, and cloud is the platform on which the new digital builders are using it. They are reimagining everything from banking, retail and healthcare to transportation, supply chains and waterways. More precisely, they are composing — writing code, connecting to pipelines of data and integrating application programming interfaces (APIs).

- By some estimates, there will be one million APIs before the end of the decade — including cognitive APIs.

- In 2014, developers used an average of 15.4 APIs on a typical software project. By 2017, this is expected to rise to 19.1.

- Of the 18.2 million software developers in the world, 1.2 million are now publishing APIs for external use and 4.7 million are limited to their partners or registered associates.

- 670,000 developers are working across the Apple and Google platforms — which make up four-fifths of all available apps. They are submitting more than 2,000 apps a day.

- By 2020, it is estimated that 26 billion devices will be using one trillion applications.

3. **The advent of cognitive computing.** Cognitive systems can ingest unstructured data in all its forms. And business leaders across all industries are acutely aware of the need to address this phenomenon. Among C-Suite executives familiar with cognitive computing:

- 89% in telecommunications believe it will have a critical impact on the future of their business.
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• 84% in healthcare believe it will play a disruptive role in the industry — and 60% believe they lack the skilled resources and technical expertise to achieve it.

• 94% of C-Suite executives in retail and 96% in insurance intend to invest in cognitive capabilities

Cognitive systems:

• Understand unstructured data, through sensing and interaction;

• Reason about it by generating hypotheses, considering, arguments, and recommendations; and

• Learn from training by experts, from every interaction, and from continually ingesting data. In fact, they never stop learning.

This is Watson, the world’s first cognitive system.

When it played Jeopardy! in 2011, Watson did one thing: natural language Q&A, powered by five technologies, among them machine learning and natural language processing. Today, Q&A is just one of 28 Watson capabilities — and they have all been turned into digital services, or APIs. Think of these as cognitive building blocks.

• Those APIs — including relationship extraction, personality analysis, tone analysis, concept expansion and trade-off analytics — are powered by 50 technologies.

• We will increase by 50% the number of Watson services by the end of 2016.

• And we will keep adding capabilities.

A key decision we made was to open up Watson as a cloud-based API platform — to nurture an ecosystem so that anyone could build Watson capabilities into their applications. We believed this would scale and accelerate innovation, and it’s working:

• Today, clients in 36 countries, across 17 industries are applying cognitive technologies.

• Start-ups and innovators in established businesses are leveraging the Watson Developer Cloud — a platform used by more than 77,000 developers globally to pilot, test and deploy new business ideas.

• More than 350 ecosystem partners and innovators in established businesses are building cognitive-enabled apps, products and services, and 100 of those have already taken their product into the market.

• There are more than 1.3 billion Watson API calls a month and growing.

We believe the convergence of these major shifts will fundamentally change companies, industries, professions and global society.

The competitive advantages of Cognitive Business

According to a leading industry analyst:

• By 2018, half of all consumers will regularly interact with services based on cognitive.

• Growth in applications incorporating advanced and predictive analytics, including machine learning, will accelerate in 2015. These apps will grow 65% faster than apps without predictive functionality.

• Decision management platforms will expand at a CAGR of 60% through 2019 in response to the need for greater consistency in decision making and process knowledge retention.

Consider what becomes possible when data — all the world’s data — is opened to cognitive systems that understand, reason and learn:

1. Deeper human engagement: Cognitive businesses create more fully human interactions with people — based on the mode, form and quality each person prefers. They take advantage of what is available today to create a fine-grained picture of individuals — geo-location data, web interactions, transaction history, loyalty program patterns, EMRs, data from wearables — and add to that picture details that have been hard or impossible to detect: tone, sentiment, emotional state, environmental conditions, strength and nature of a person’s relationships. They reason through the sum total of all this structured and unstructured data to find what really
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matters in engaging a person. By continuously learning, these engagements deliver greater and greater value, and become more natural, anticipatory and emotionally meaningful.

- By 2020, about 1.7 megabytes of new information will be created every minute for every human being on the planet.
- Marketers are achieving 15–20% ROI improvements by putting data-driven personalization at the center of their efforts.
- Pandora uses more than 450 attributes to personalize their service.
- The average wearable device (e.g., fitness tracker, smart watch) shipped in 2019 will incorporate 4.1 sensor elements, up from 1.4 in 2013.
- 54% of healthcare executives in Western Europe are investing in RFID to improve patient identification, logistics and asset management.

For example, Gwinnett County Public Schools uses data on student performance and interaction, aptitude and learning style, plus a broad range of instructional materials, to develop experiences and curriculum tailored to each individual student. The system guides students toward appropriate post-school opportunities and red-flags warning signs, such as potential for drop-out. From 2011 to 2014, graduation rates have risen 7.4%.

And this isn’t unique to education. Banks are analyzing masses of data around financial planning, strategy and investment, along with individual investor sensibilities, to make better investment recommendations. A major insurance company built a Watson-based digital assistant that answers complex inquiries in natural language and coaches the user to complete the sale. And 20 million hotel guests next year will have access to Ivy — an automated guest engagement platform powered by IBM Watson — that can welcome them, deliver instant service and help hotel staff improve satisfaction.

2. Elevated expertise: Every industry and profession's knowledge is expanding at a rate faster than any professional can keep up with — journals, new protocols, new legislation, new practices, and entire new fields.

Healthcare offers a clear example:

- It is estimated that the doubling time of medical knowledge in 1950 was 50 years; in 1980, 7 years; and in 2015, less than three years.
- Each person will generate one million gigabytes of health-related data in his or her lifetime — the equivalent of about 300 million books.
- By 2035, there will be a gap of 13 million qualified healthcare workers.
- In the US, the #3 cause of death is preventable medical errors.
- Against that backdrop, more than half of healthcare industry CXOs report that they are not confident in making strategic business decisions — based on current constraints on their ability to use available information, and the existing capability to deal with the complexities of demand and the regulatory environment.

Meanwhile, developing expertise in any field operates on a very different time and cost scale.

- Professional mastery can take over a decade. Consider a doctor becomes board certified in 11 - 16 years, and on average, it takes between 7 - 10 years to become a partner at a law firm.
- US organizations spent $164.2 billion on employee learning and development in 2012.
- In the US, businesses spent $156 billion on employee training in 2011; yet it is estimated that 90% of new skills are lost within a year.

Finally, there is a large gap in the quality of outcomes between average and top performers. For transplant surgeons, it is estimated at 6x; for a sales associate at Nordstrom’s, 8x; an Apple developer, 9x; a line cook, 10x; and a blackjack dealer at Caesar’s, 5x.

Cognitive systems are designed to keep pace, serving as a companion for professionals to enhance their performance. Because these systems master the language of professions —
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the language of medicine, or sales, or cuisine — they can teach complex expertise. This reduces the time required for a professional to become an expert.

What’s more, because these systems are taught by the leading practitioners — whether in customer service, oncology diagnosis, case law or any other field — they make available to broad populations the know-how of the best. And for the highest masters of a profession, cognitive systems are a unique partner and collaborator — providing far deeper and faster research than they could ever accomplish on their own, and sharing the knowledge of hundreds, even thousands of other talented practitioners.

For example, the average primary care doctor in the US has a caseload of 2,300 patients and spends 15 minutes per patient visit. Bumrungrad International Hospital takes Watson for Oncology — which was trained by world-leading cancer physicians and researchers — and makes it available to its network of more than a million patients across Southeast Asia.

We see expertise being enhanced by cognitive systems across multiple industries and sectors. For example, constabularies in the UK are turning greater insight into pre-emptive policing. Law firms in the US are providing better, more cost-efficient legal services and are serving more clients by enhancing their legal research skills.

3. Cognitive products and services: Cognition enables new classes of products and services to sense, reason and learn about their users and the world around them. This allows for continuous improvement and adaptation, and augments their ability to deliver on products and services not previously imagined.

For example, Elemental Path, a Watson ecosystem partner, built a cognitive toy dinosaur that responds to a child’s questions in an age-appropriate way — telling stories and knock-knock jokes. The toy develops a unique personality that evolves based on its interactions with the child.

We see this happening with cars, medical devices, appliances and more. Again, this is possible because the world is being rewritten in code.

• A pacemaker has 80,000 lines of code. An HD DVD player has 4.7 million lines. A Boeing 787 has 14 million lines of code. The typical new car has 100 million lines.

• Globally, there were 400 million smart meters in 2014. That number is expected to top 925 million by 2020.

• Smart, connected white-goods — including washing machines, clothes dryers, dishwashers, refrigerators, room air-conditioners and large cooking appliances — will grow from less than 1% of the market in 2014 to 51% in 2020 — and the number of connected things in smart homes is expected to surpass 1 billion globally in 2017.

• Smart TVs grew from 27% of the market in 2012, to more than 50% in 2014. By 2018 they will make up 82% of all TV sales.

• By one estimate, the installed base of “connected things” for transportation (roadway sensors, smart traffic signals, etc.) within smart cities will grow from 237 million units in 2015 to 371 million in 2017.

4. Cognitive processes and operations: Cognition also transforms how a company operates and functions. Business processes infused with cognitive capabilities capitalize on the phenomenon of data, from internal and external sources. This gives them heightened awareness of workflows, context and environment — leading to continuous learning, better forecasting and operational effectiveness — along with decision-making at the speed of today’s data.

This is good news.

• By one estimate, $30 billion is wasted every year due to poor coordination among supply chain partners.

• An average billion-dollar company spends almost 1,000 person hours a week managing its suppliers.

For example, a retailer has laid the groundwork for a cognitive supply chain, reducing demand forecasting errors by 50%. They apply predictive analytics to both in-house structured data and eight categories of unstructured data, including Twitter sentiment, local events and weather patterns. Behavior that previously seemed random can now be predicted, and inventory can be located much closer to the right stores.

Operational cognition is also enabling an airline to reduce
discretionary fuel costs, a car maker to reinvent its approach to product recalls, and an oil and gas company to distill 30 years of know-how in managing liquid gas facilities into a cognitive advisory service for its employees.

5. Intelligent exploration and discovery: Ultimately, the most powerful tool that cognitive businesses will possess is far better “headlights” into an increasingly volatile and complex future. Such headlights are becoming more important, as leaders in all industries are compelled to place big bets — on drug development, on complex financial modeling, on materials science innovation, and on launching a startup. By applying cognitive technologies to vast amounts of data, leaders can uncover patterns, opportunities and actionable hypotheses that would be virtually impossible to discover using traditional research or programmable systems alone.

For example, in a test, Baylor College of Medicine had their researchers use Watson to help analyze 70,000 scientific articles, identified from 23 million candidate documents. In just a few weeks, Watson accurately targeted seven proteins that modify p53 — an important protein related to many cancers. This level of discovery had typically taken the entire life sciences industry seven years to accomplish before Watson came along.

Similar forms of discovery are expanding fields from resource extraction and materials science, to psycho-pharmaceuticals.

- The cost of new drug development has increased 145% over the last decade, and 42% of CXOs believe rigid and insufficient analytic tools are a major barrier — with 94% saying cognitive computing will be a disruptive force in life sciences.
- One rough estimate has it that 600 petabytes of data are associated with finding, stimulating, extracting and moving shale hydrocarbons.

Every industry is being transformed by data. Every industry will become cognitive in some way. And this is why IBM has developed industry-specific Watson units.

The first of these was Watson Health, and its centerpiece is the Watson Health Cloud. This platform provides Bluemix services, powerful analytics, the Watson APIs and massive data sets specific to health and wellness from our clients and ecosystem partners. It includes the medical image data we have acquired through Merge — giving Watson the ability to “see.” On this platform IBM, our partners and clients are building unique solutions that will transform healthcare, like:

- **Real-World Evidence**, drawing on data from our recent acquisition of Explorys
- **Condition-Specific Care**, including expertise from Johnson & Johnson and Medtronic, to help patients recover after knee surgery
- **Social Programs**, in which Curam will ensure that care addresses individuals’ social context
- And **Health and Wellness solutions**, with Apple apps and data from wearables

We will establish Watson businesses to serve additional industries.

Cognitive capabilities are also being infused into the parts of IBM that cut across several industries and professions. Take IBM Commerce as an example: We are tapping into Watson APIs such as sentiment analysis, tone analyzer, personality insights and message resonance to help our clients know their customers as individuals and to engage them on their terms — with the right offers, messages and actions to drive their beliefs and behaviors. And this is just the beginning; we will continue to build deeper cognitive capabilities to benefit our clients.

**The path to Cognitive Business**

As with Smarter Planet, Cognitive Business is much more than a marketing platform. It speaks to IBM’s strategy and purpose. It is a powerful and urgent idea, grounded in real science and extensive applications in business and society.

To take the journey — to become a cognitive bank, a cognitive retailer, a cognitive hospital, to build a cognitive supply chain — leaders capitalize on all the work they’ve done to deploy cloud, analytics, mobile, social and security. They can
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take these investments to the next level — drawing on the breadth and depth of the entire IBM Company — by developing:

**A cognitive strategy**

Where will you start, and how will you apply cognition to fundamentally transform your business? This means determining what data you need; which experts will train the system; where you must build more human engagement; which products, services, processes and operations should be infused with cognition; and which parts of the 80% of unstructured data you most need to focus on to see your future.

- **Why IBM: IBM Global Business Services.** Already a leader in analytics consulting, IBM has launched the industry’s first cognitive consulting practice, with hundreds of analytics experts — supported by 2,000 specialists, drawing on IBM’s collective experience of 50,000 analytics engagements, as well as partnerships with Apple, Facebook and others.

**Robust data and analytics capability**

Enterprises that will win are those that collect and curate the right data — data they own, data from others, data available to all — both structured and unstructured. They apply cognitive technologies to this data to sense, learn and adapt — creating competitive advantage.

- **Why IBM: IBM Analytics.** IBM leads the way by building diverse data partnerships with the likes of Twitter and the Weather Company, embedding analytics into everything from Apache Hadoop to stream computing, building next-generation analytics platforms such as Spark and continually embedding knowledge into accessible solutions.

**Cloud services optimized for industry, data and cognitive services — a platform for the new builders**

Coders are the new builders — the makers of new products and services that generate new kinds of value. Their building blocks are code, APIs and diverse data sets. The platform you choose to develop on, and the agile development culture and methods you embrace, will be critical to your success.

- **Why IBM: IBM Cloud.** In its first year, Bluemix, IBM’s cloud-based application development platform became the largest Cloud Foundry deployment in the world, with more than 100 services, in 179 countries and thousands of new users each week, many seeking to take advantage of our Watson APIs. And IBM Cloud — including Softlayer IaaS and pods in 41 countries — offers the world’s most robust, complete and secure hybrid enterprise cloud solution.

**IT infrastructure tuned for cognitive workloads**

To build cognition into the objects, products, systems, and enterprise resources that matter, you must architect a new kind of IT core — a heterogeneous infrastructure that serves as the backbone of your enterprise. To do this rapidly and affordably, you must harmonize technologies from public, private and hybrid cloud with distributed devices, IoT instrumentation and your existing systems.

- **Why IBM: IBM Systems.** IBM’s POWER8 is designed for the demands of cognitive computing. And we have committed more than $1 billion over five years to develop next-generation technology in software-defined storage to handle the intense data needs of cognitive businesses.

- **Why IBM: IBM Global Technology Services.** GTS has already implemented the cognitive desk agent — human agents backed by the power of Watson — who can determine problems 37% faster and provide more effective solutions. As well, our dynamic automation responds and adapts to changing circumstances in the IT environment. For instance, we are able to address 64% of incidents that happen with our “virtual engineer,” which reduces the time it takes by an average of 80 minutes per situation.

**Security for a cognitive era**

Cognition is making its way into cars, buildings, roadways, business processes, fleets, and supply chains. This means securing every transaction, piece of data, and interaction is now essential to ensure trust in the entire system, in your brand and reputation.

- **Why IBM: IBM Security.** Building on our leadership in intelligence-driven security and the shared insights of more than 2,000 participating organizations and 700 terabytes of threat intelligence data in IBM X-Force Exchange, IBM is best poised to bring cognition to enterprise security. Cognitive security systems will learn from the 15 billion security events that IBM manages every
Today, enhancing the expertise of security analysts and adapting to a rapidly evolving threat landscape.

On the far horizon, IBM Research is creating a pipeline of advanced technologies that give us confidence in an even richer transformation to come. For example, Watson will see and hear things no human can—from the infrared spectrum to the pulse of a city. We continue to invest in the next-generation infrastructure that will be required to support this new era—as well as new computing architectures, such as neuromorphic computing and quantum computing.

Conclusion

It’s quite simple—the world needs Watson. No human, no organization, no city or nation can keep up with all the volume, velocity and variety of data. And no legacy programmable system—even the most advanced supercomputer—can understand the 80% of data where the deepest insights and meanings lie.

In the not too distant future, it will simply be unacceptable for something—an application, a product, a car, a room—not to:

• Truly recognize and know you
• Sense context and environment
• Know what’s happening in the world that’s relevant to that moment, that interaction, that situation
• Personalize its actions, recommendations and answers, based on what it understands
• Improve itself over time, not by being replaced by newer versions of itself

It will interact with you in a very natural way, based on knowing you, and you will sense pretty quickly whether the thing you’re interacting with has been pre-programmed.

This is inevitable. The technology is here and it will only become richer and more capable. Companies will embrace cognitive, because if they don’t, someone else will. It’s all about competitive advantage.

Technology revolutions are not driven by discovery alone, but also by business and societal needs. The leaders of every era undertake grand challenges—some call them ‘moonshots’—not just because they can, but because they must.

In past generations, IBM’s moonshots were the creation of Social Security systems, the enabling of modern finance, air travel, retail. They were literally helping to put a man on the moon.

Today, we can change the face of healthcare. We can reimagine education. We can reduce the risk in ever-more-complex global markets.

And if we can, we must.

There are, of course, significant issues to address—as with every technological revolution. Issues about how it will affect skills, and about security and privacy. For all the fascination with Artificial Intelligence these days, there is, for some people, anxiety. These are important challenges, but not insurmountable ones. IBM will not only introduce cognitive innovations—we will help the world apply them responsibly. This, too, is what our clients and the world expect from IBM.

At IBM, we are optimistic about the cognitive future, and are working hard with our clients, partners, peers and civil society to build it.