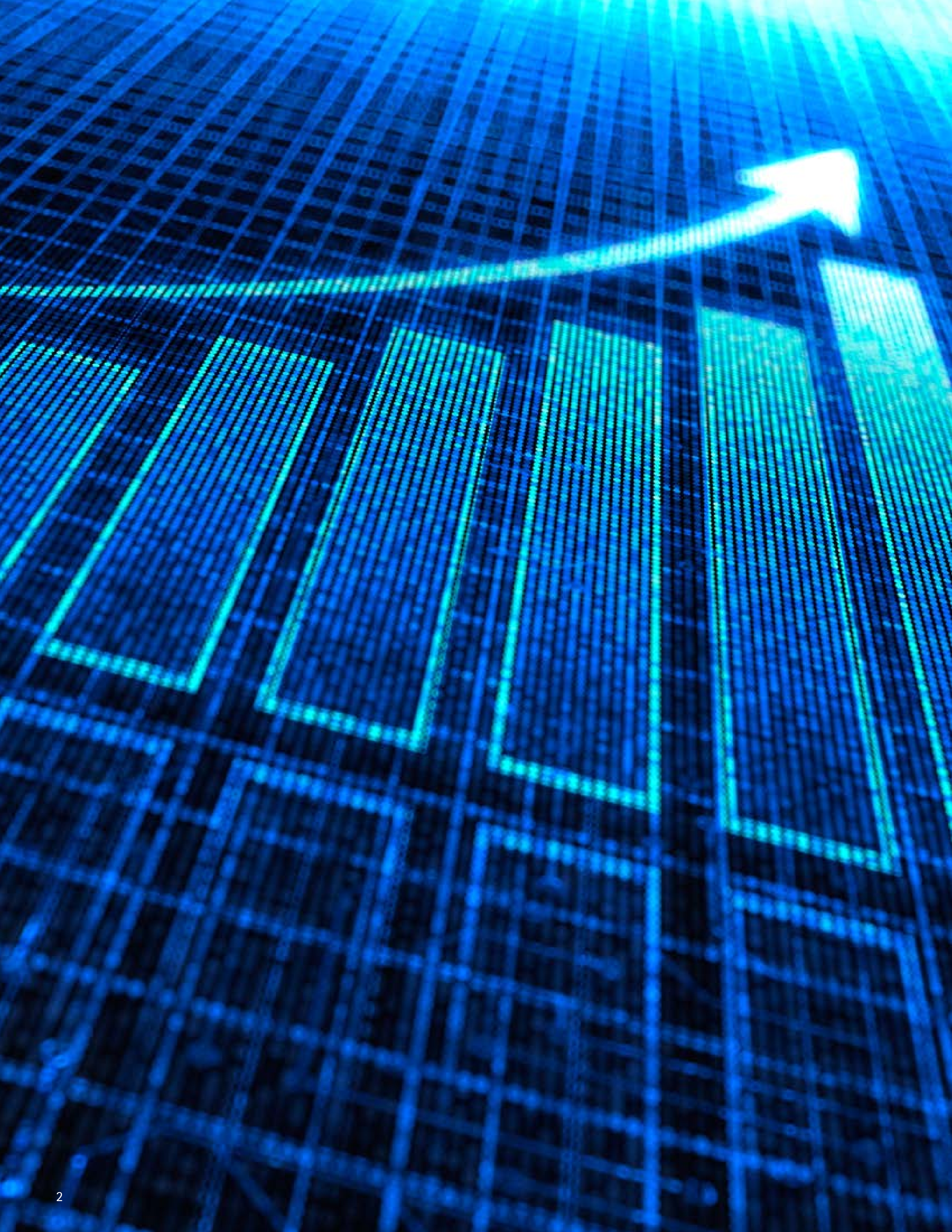
Turning Cognitive Computing into Business Value. Today.

High performance. Delivered.

accenture

Strategy | Digital | Technology | Operations



Turning Cognitive Computing into Business Value. Today.

By Cyrille Bataller and Jeanne Harris

The economic and business potential of Cognitive Computing has filtered up to the C-suite. But how can executives weed out the hype while at the same time guiding their organizations to capture new value in this promising area? This paper offers a perspective on how these technologies are impacting business and society, and presents a framework for understanding how Cognitive Computing can deliver value for your organization and industry.

Introduction

Cognitive computing is a hot topic these days, drawing the attention of C-suite executives, not just technologists and research scientists.

Cognitive Computing—which Accenture defines as information systems and applications that can sense, comprehend and act—has captured the attention of C-suite executives, not just technologists and research scientists.

The media regularly draws attention to innovative business solutions based on Cognitive Computing. Venture capitalists are funding Cognitive Computing start-ups at a rapid pace.

Technology companies are moving swiftly to create and capture value in this emerging area. High-profile acquisitions by Google[1], Apple[2] and Facebook[3] are piquing interest in Cognitive Computing technologies such as robotics, expert systems, computer vision, and speech, gesture and facial recognition. Companies are creating new research labs devoted to innovating with these technologies, and the number of Cognitive Computing vendors has increased dramatically.

Cognitive Computing technologies and solutions also face several obstacles. As with any new technology promising to change the world, business leaders wonder how to separate hype from real potential. From there it's a short step to wondering if *their* organization will be one of those that figures out how to capture new value —or will be one of those playing catch-up. Add to this skepticism and lack of understanding as well as the widely discussed apprehension about the social and economic implications of these technologies, and it's clear that Cognitive Computing faces serious headwinds.

But executives shouldn't let these concerns obscure the considerable likely benefits of Cognitive Computing. These include lower costs for services, better quality and consistency of services, improved education and medical treatment, and better, faster, more informed business decisions.

Decision makers should also recognize that Cognitive Computing isn't a matter of any single technology or application—whether driverless cars or smartphone virtual assistants or trend detection solutions or a myriad of other examples. Cognitive Computing is a rich and diverse field. The greater value will come from understanding the multitude of related technologies and then integrating those technologies into full solutions. (See Figure 1.)

Figure 1: Examples of how cognitive technologies can be integrated into compelling business solutions

Technology	Definition	Example Solutions
Sense		
Computer vision	Acquiring, processing, analyzing and understanding images	Video analytics integrated with surveillance cameras provides situational awareness of business operations, delivering insights about risk, safety and security. In retail, video analytics can be used to gain insights into shopper behaviors effectively and systematically.
Audio processing	Identifying, recognizing and analyzing sounds and speech	Speech recognition technologies integrated into call centers automate the identification of callers.
Sensor processing	Processing and analyzing information from sensors other than cameras and microphones	In an agricultural setting, sensors in the field can be integrated with software to deliver "precision agriculture"— sensing and communicating status about temperature, humidity, etc., enabling more precise care for crops.
Comprehend		
Natural language processing	Understanding and generating language in spoken and/or written form	Personal assistants on consumer smart phones provide guidance and services using natural language. Increasingly, search capabilities include the ability to understand the meaning of what a person is saying, not just recognizing key words or doing statistical retrieval.
Knowledge representation	Depicting and communicating knowledge to facilitate inference and decision making	Knowledge-based tools provide the capability to link a particular search or piece of content to other relevant content on the web. This is done by tagging all content and then mapping it to a larger representation of knowledge. For example, a search for "Da Vinci" will link one to particular paintings and creations, as well as to Italy, to the Renaissance, and so forth.
Act		
Inference engines	Deriving answers from a static knowledge base such as business rules	Solutions can apply rules to make automated loan approval or credit decisions, or granting of visas. Such capabilities can deliver accurate decisions in a fraction of the time of manual decision making.
Expert systems	Emulating the decision-making ability of a human expert and solving complex problems by reasoning with the information available in its knowledge base	Medical diagnostics as well as legal research can be significantly aided by the ability of expert systems to sift through millions of data sources, synthesize information and present it to a user.
Machine learning	Altering the decision process based on experience	Software tools and personal agents can learn from users to improve productivity—for example, by sorting email, then extracting calendar entries and action items.

Cognitive Computing: Systems that can sense, comprehend and act

Cognitive Computing systems can be self-learning. They are like bright students who are given educational materials and then can learn by themselves.

Cognitive Computing consists of multiple technologies that enable information systems and applications to sense, comprehend and act. That is, computers are enabled (1) to perceive the world and collect data; (2) to analyze and understand the information collected; and (3) to make informed decisions and provide guidance based on this analysis in an independent way.

Cognitive solutions can also learn from experience and alter their processing and behavior based on those learnings (Figure 2).

Sense

Consider how a border-control kiosk uses computer vision technologies such as facial recognition to sense characteristics of travelers. Integrated with other technologies such as multispectral image analysis (scanning passports using infrared and ultraviolet light), extensive information databases and matching algorithms, an integrated solution here can improve security by identifying people on unauthorized entry lists or others posing a risk.[4] Video analytics is another sensing technology that can automate observation and incident detection by video surveillance cameras. Other similar applications can help companies improve physical security at their premises, or they can help retailers count visitors or recognize customers as they enter a store so sales people can provide personalized services.[5]

Comprehend

Cognitive Computing systems also comprehend through technologies such as natural language processing, inference engines and expert systems. These technologies have a wide range of applications across multiple industries. For example, a medical diagnostic system can help doctors identify diseases and suggest treatments. As shown in Figure 3, a doctor (1) interacts with the system by speaking or typing in a native language. The system (2) asks follow-up questions and (3) stores facts in working memory, then (4) takes the facts of the case and the knowledge it has of medicine and cases (stored in a knowledge base) and infers a solution or treatment. Finally, (5) the system presents a conclusion or suggestion to the doctor, who uses it as expert input into a final diagnosis and treatment plan.

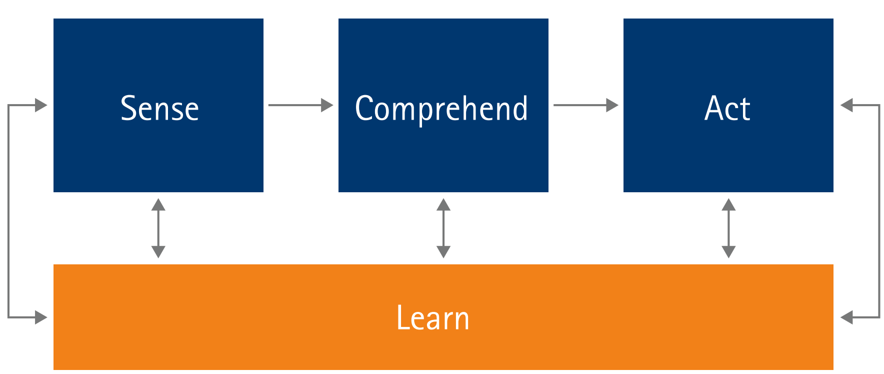
Act

A cognitive system acts independently. It can take action within a process, through technologies such as inference engines and expert systems, or it can direct action in the physical world. Consider a widely publicized example of the driverless car which senses the environment, understands the myriad inputs and then steers the car without assistance from a human driver. Other examples include factory robots that assemble products on the production line, virtual assistants that act by responding to customer or consumer inquiries, and assisted-braking capabilities in cars that sense skids and automatically take action to steer the car safely.

Learn

A distinctive feature of all types of true Cognitive Computing solutions is their ability, through a technology known as "machine learning," to adapt their capabilities based on experience, rather than needing to have all the rules hard-coded. For decades, computers have been able to process complex questions and give answers, but applications were rigid and any change required programmatic modifications. Today, Cognitive Computing systems can be self-learning; they are more like bright students who are given educational materials and then can learn by themselves.

Figure 2: Cognitive Computing solutions can sense or perceive the world and collect data; understand the information collected; and act independently—all underpinned by the ability to learn and adapt over time

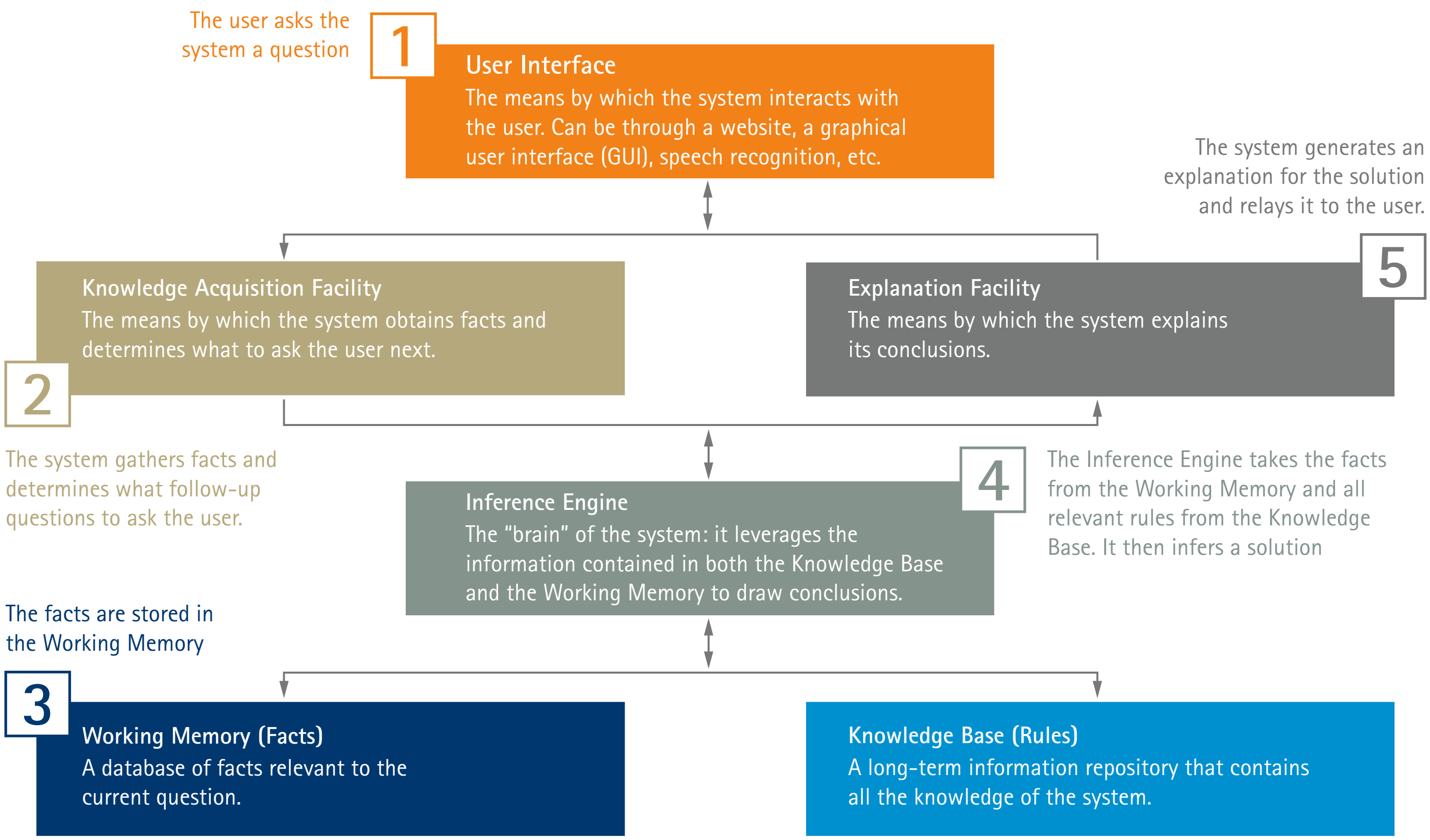


For example, self-learning Cognitive Computing solutions are already in use by banks to detect credit fraud. The banks use machine learning models that understand previous spending patterns of a customer and predict the transactions a person will make, flagging unusual activity. These systems are also given real examples of fraudulent and legitimate transactions so that the models can learn to recognize new patterns and evolve as fraudsters alter their tactics.

At the consumer level, an example of a self-learning application is Google Now, a personal assistant. It learns from its user's activities and interactions to find, collect and present relevant, personalized information on a smartphone. Google Now is also designed to constantly improve based on user feedback and its own learning methods.

Technology advancements are continuously improving the sophistication of computers' learning capabilities. A form of machine learning called "deep learning" is being used today to develop systems that can perform more complex activities using neural networks to mimic the human brain structure. Such systems are increasingly able to do things like recognize patterns and objects, and generate descriptions of images in natural language.

Figure 3: A medical diagnostic expert system comprehends input from a doctor, searches a knowledge base, infers solutions and suggests conclusions or treatments



Realizing business value: A framework for identifying Cognitive Computing opportunities

One way to classify and explain the range of available Cognitive Computing solutions is to think of them in terms of both automating and augmenting.

Automation of routine tasks can improve overall productivity and performance. In financial services, for example, many routine policy decisions—such as determining whether someone qualifies for a loan or for insurance benefits—can be time consuming and technical for humans. Automated systems can make these decisions quickly, accurately and consistently.

On the other hand, many other activities do not (and perhaps will not ever) lend themselves to automation, so it is better to think in terms of *augmentation*. As in the medical example cited earlier, expert systems are better than humans at sifting through gigabytes of data related to a particular medical condition. However, many patients in a healthcare setting would be reluctant to receive diagnosis, prescription and treatment from a machine. Similarly, smart machines are already augmenting the work of surgeons and fighter pilots, but it would be inappropriate or even impossible to automate that kind of work—where real-time human analysis of a situation and the application of judgment are essential.

Two criteria for analysis

As companies consider how best to apply this new wave of technologies to their business, they need a way to think about what types of work can be automated or augmented by Cognitive Computing solutions. The matrix shown in Figure 4 provides this kind of guidance. For a particular type of work activity, Cognitive Computing solutions can be considered based on two criteria: first, the complexity of the work that is being done and, second, the complexity of the data and information being worked with.

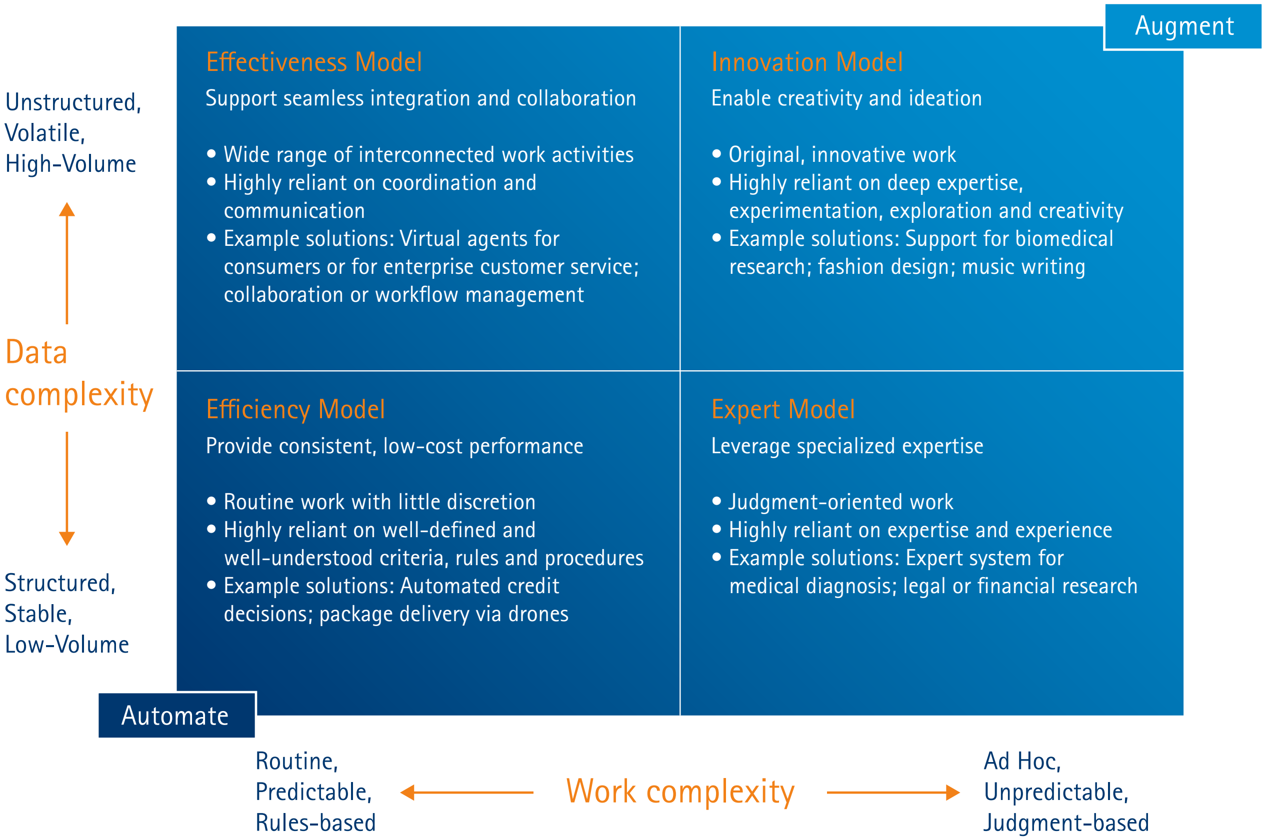
On the one hand, the work itself may be routine, predictable and rule-based—clerical work and claims processing, for example, or credit decisions. At the other end of the spectrum activities might be more ad hoc and unpredictable and require the application of human judgment—the work of research scientists, for example, or architects, financial advisors and consultants.

In terms of data complexity, data is sometimes quite structured, stable and low-volume—for example, budget data or sales data. In other cases, at the other end of that spectrum, data can be unstructured, volatile and high-volume—social media, multimedia data, sensor data and so forth.

The framework that results from this dual analysis—work complexity and data complexity—posits four primary types of activity models:

- Efficiency
- Expert
- Effectiveness
- Innovation

Figure 4: By sorting tasks into four activity models, particular types of Cognitive Computing solutions can be identified



As the color gradation of the matrix suggests, activities that are closer to the bottom left of the matrix are more likely to involve Cognitive Computing work automation, while those closer to the upper-right part of the matrix are more likely to use Cognitive Computing to augment human capabilities. It is also important to note that many jobs will have aspects or characteristics that span the different models. For example, some aspects of the work of a lawyer or doctor might fall under Efficiency and Effectiveness, while other aspects might be more in line with the Expert and Innovation models.

Let's look in more detail at each of the four models.

Efficiency model

First, at lower left on the matrix is the efficiency model, which characterizes more routine activities based on well-defined rules, procedures and criteria. The goal here is to provide consistent, low-cost performance. In these solutions, technology senses, comprehends and acts, while the role of humans is to monitor the accuracy of the solution as well as to determine how the rules need to evolve as business conditions change. Over time, machine learning capabilities will increasingly improve such rules.

An example of the efficiency model can be seen in automated decision-making capabilities that can now be embedded into the normal flow of work: systems sense online data or conditions, apply codified knowledge or logic, and make decisions—all with minimal amounts of human intervention. These systems are also configured to translate decisions into action quickly, accurately and efficiently.

Expert model

In this model, work is more likely to involve judgment and is highly reliant on individual expertise and experience—activities performed, for example, by doctors, lawyers, financial advisors and engineers. Decision-making and action is generally taken by humans themselves, while technology's role is to augment human sensing and decision making—enabling analysis and offering advice and implementation support.

So-called "expert systems" are examples of Cognitive Computing solutions within the expert model. Such systems are capable of searching vast data stores, and then making inferences and recommendations based on that knowledge. An important distinction among these expert solutions, however, is whether the system is functioning as a primarily autonomous system—for example, "given your travel parameters, here are some itinerary recommendations"—or whether it is providing input to human judgment.

The medical diagnostic system discussed earlier is an example of an advisory system that augments human understanding and judgment. Given the nature and importance of doctor-patient relationships, medical doctors themselves would most likely want to interpret the results of the expert system's analysis and present a personalized diagnosis to the patient. In other cases (such as a car configurator on a manufacturer's website), a personal relationship may be less important, so the expert system might interact directly with a user in natural language, without the need for a human intermediary exercising interpretation and judgment.

Effectiveness model

As its name suggests, the goal of the effectiveness model is to improve the overall ability of workers and companies to produce a particular desired result. This class of workers typically requires considerable knowledge of their industry, company and business processes. Their success is highly reliant on coordination and communication and involves a wide range of interconnected activities—work such as administration, managing, sales and so forth. In these solutions, technology acts as personal assistant or agent on behalf of humans at their direction; humans use the cognitive tools to assist in scheduling, communicating, monitoring and executing activities. Cognitive Computing helps workers be better at what they do.

Virtual agents, whether consumer or corporate, are excellent examples of Cognitive Computing solutions within the effectiveness model. Consumers are increasingly using agents such as Siri, Cortana and Google Now on their smartphones. Virtual agents receive requests in a textual or verbal form, process them using technologies such as natural language processing or speech recognition, search their knowledge repositories or the Internet, formulate hypotheses and then give the answers back to the users, again in text or speech.

At the corporate level, virtual agents are beginning to handle many of the routine questions that come into a customer service center. Only when questions are not resolvable from an automated knowledge base would a user be referred to a live agent.

Innovation model

In this model, Cognitive Computing solutions enhance creativity and ideation by humans—activities and roles such as biomedical researchers, fashion designers, chefs, musicians and entrepreneurs. Humans make decisions and act, while technology helps identify alternatives and optimize recommendations.

An example of how Cognitive Computing can augment creative behavior is an intelligent software program from Platinum Blue Music Intelligence. The program can analyze a song and provide recommendations to increase the likelihood that the song will be a hit (by fine-tuning the bass line, for example).

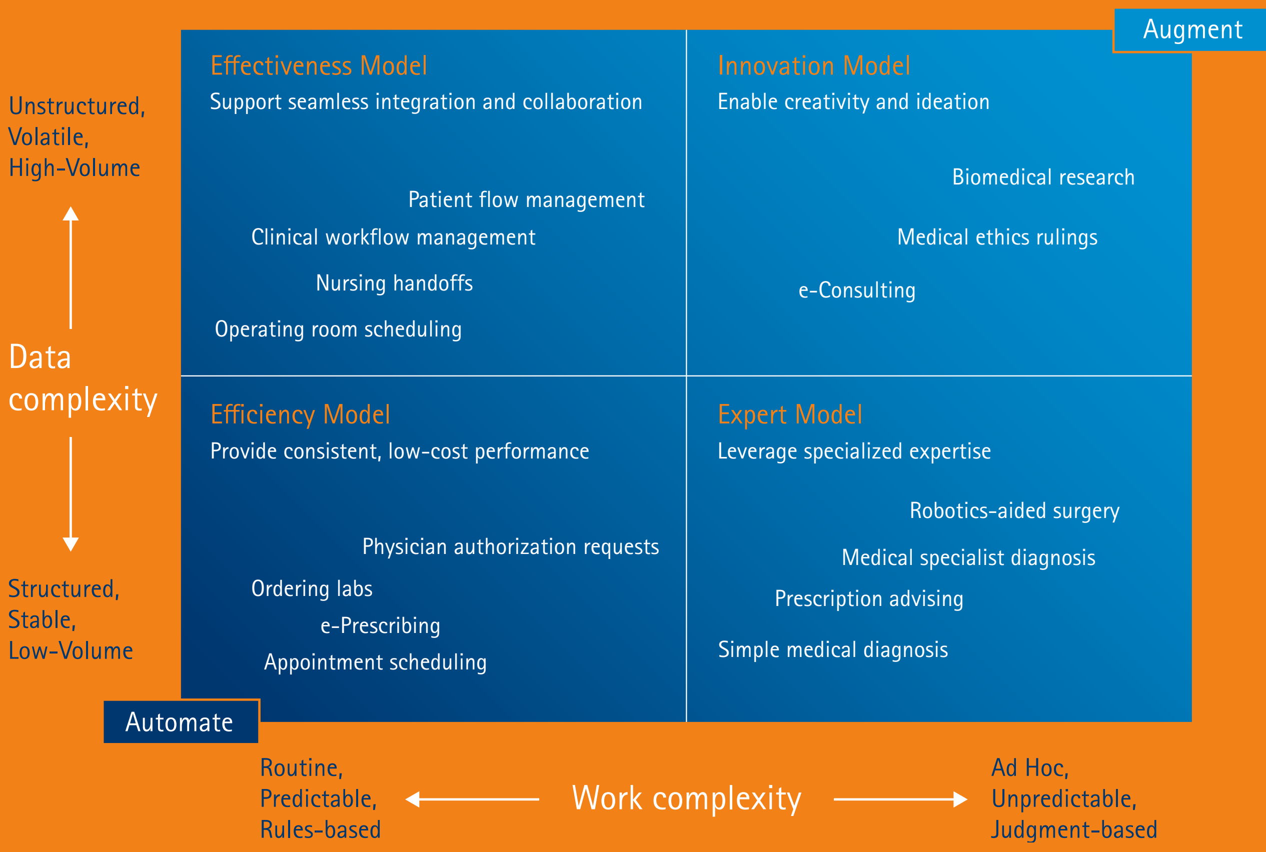
Billed as a tool to assist artists and producers, Platinum Blue's technology uses spectral sound-wave analysis to offer advice. For example, the tool was used to analyze the song "Crazy," by Gnarls Barkley. The analysis found that "Crazy" belonged to the same hit cluster as several recent hit songs as well as older hits by Olivia Newton-John and Mariah Carey. The data indicated that "Crazy" was going to be a huge success, which it was.[6]

Understanding the potential for Cognitive Computing solutions: Industry examples

As demonstrated in these figures, executives from different industries can use the Cognitive Computing framework to plot different work activities within the matrix. By understanding the complexity of different work activities, as well as the complexity of the data and information used for those activities, particular Cognitive Computing solutions can be planned, designed and implemented.

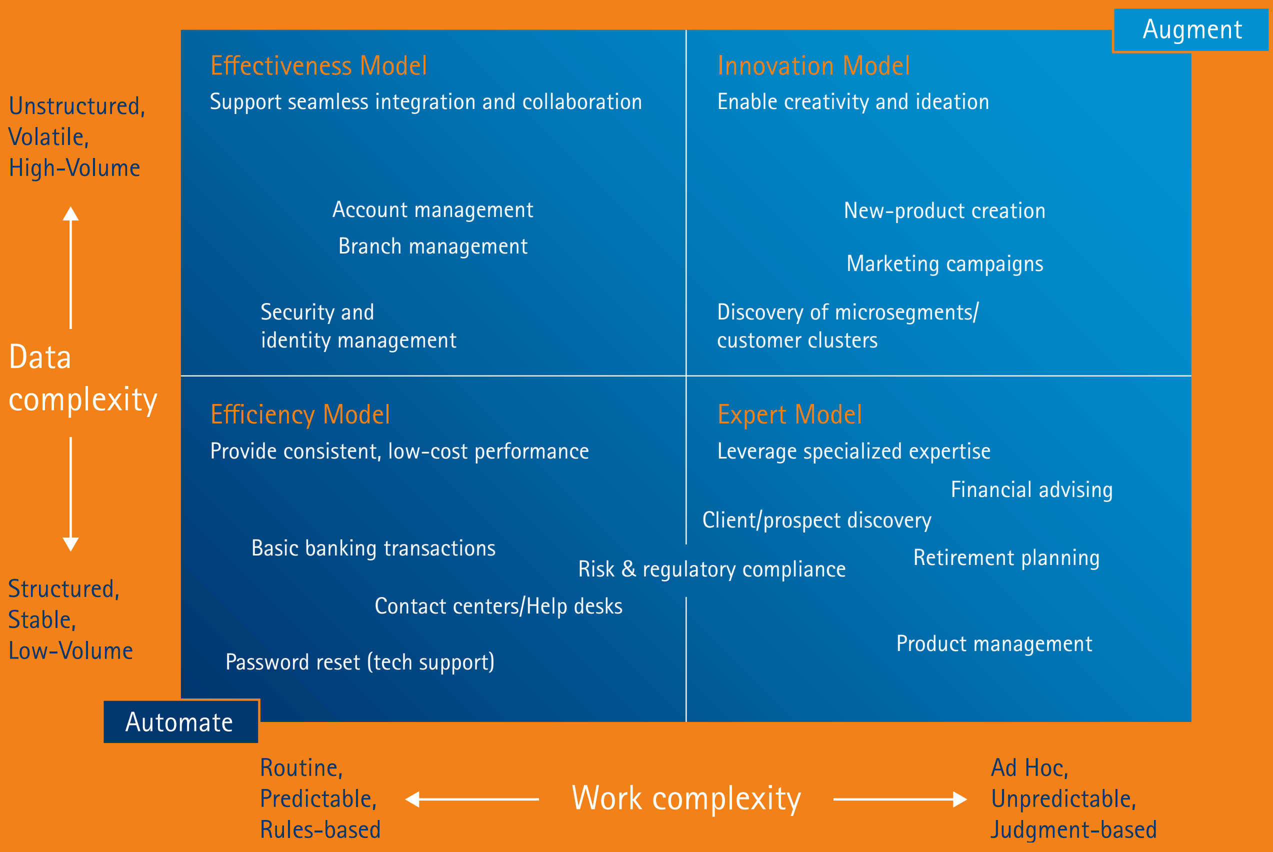
For purposes of illustration, we demonstrate how the framework could be used in the healthcare and banking industries.

Healthcare example



In healthcare, Cognitive Computing technologies can be applied in different ways for different tasks and activities to deliver a total solution. Routine and predictable tasks such as appointment scheduling can be automated, while activities such as e-Consulting and biomedical research would use technology to augment human actions.

Banking example



In banking, transactions are being driven toward greater efficiency through automation, while greater effectiveness through Cognitive Computing is the goal for activities such as security and identity management. For work such as financial advising and retirement planning, human interaction is essential; nevertheless such activities can be aided by expert systems, automating some tasks and augmenting others.

Cognitive Computing challenges

Cognitive Computing can represent the best kind of collaboration between humans and machines.

Creators of Cognitive Computing business solutions may face different kinds of challenges and pushback.

Unease about near-human capabilities

Many people feel uneasy about robots or animations that are humanoid and that almost—but not quite accurately—appear real. The "almost" is what is unsettling for people (think zombies or automatons or some representations of people in a wax museum). Due to the "almost" phenomenon, businesses need to be selective in the solutions they choose to make sure their customers and employees have a pleasant experience, not an unnerving one.

Vendor hype

Given past disappointments with earlier phases of artificial intelligence, as well as overly bullish claims often made about technologies, a degree of careful consideration is warranted. Developers need to look especially at how a particular technology or offering can integrate with others to deliver a total solution. Companies should also look to pilot and test solutions to understand their capabilities and limitations.

Different development approach

Most development in a traditional systems environment follows the usual phases of plan, analyze, design, build, test and deploy. The Cognitive Computing environment is quite different. In deploying an expert system, for example, development is more about identifying data sources and then gathering content, cleansing it and curating it. Such an approach requires different skills and mindsets, as well as different methodologies. In addition, cognitive systems generally have to be trained in a particular domain—similar to how we train new employees—before they are useful. In short, Cognitive Computing involves a new development paradigm—not developing a system but training, coaching and supervising a cognitive solution.

Man and machine

Attitudes toward Cognitive Computing are affected by longstanding attitudes toward intelligent systems and artificial intelligence, which are often portrayed as something to be feared. From HAL, the intelligent computer in "2001: A Space Odyssey," to the "Terminator" and "Matrix" movies, fictional accounts often imply that intelligent computer systems will pit "man vs. machine"—and that the machines will turn against us. By contrast, Cognitive Computing emphasizes man *and* machine. As noted earlier, some types of cognitive solutions can free talent from routine and repetitive tasks, enabling them to work on higher-order functions. In other cases, such solutions augment human capabilities while preserving what is unique about human thinking, feeling and communicating.

Social implications

It is certainly true that larger societal issues are in play here, particularly the impact on employment. Job displacement is an issue with this era of technology change, just as it has been with earlier eras. A common theme throughout these periods of change, however, is that technology created new jobs even as other jobs were displaced. As noted in a recent report from the Pew Foundation, it is entirely possible that society will adapt by inventing new kinds of work that take advantage of capabilities that are uniquely human.[8]

Human society is amazingly resilient. As Google's Larry Page has recently said, Cognitive Computing and artificial intelligence solutions actually can represent the best kind of collaboration between humans and machines. Page notes that services like web search or automatic translation between languages already represent a high level of machine intelligence that is nevertheless under control of people. "It's learning from you and you're learning from it," Page says. "In some sense the Internet is already that: it's a combination of people and machine intelligence to make our lives better."[9]

Conclusion

Businesses, educators and policy makers will need to work together to assess impacts and take action accordingly.

Without question, Cognitive Computing is a game-changer for businesses across every industry.

A key is not to become too entranced by any particular technology, as if that technology by itself is the answer. It is vital to think first in terms of types of work, and then consider the business rationale for integrating technologies into a total Cognitive Computing solution related to that work.

It is important that business continues to engage in the ongoing dialogue about these technologies' effects on jobs, education and society. Businesses, educators and policy makers will need to work together to assess impacts and take action accordingly. What happens in terms of the social impact of Cognitive Computing is not up to the technology but to us. The business opportunity of getting it right is too significant to be left to chance.

References

[1] http://blogs.cisco.com/news/cisco-to-boost-network-security-platform-with-acquisition-of-cognitive-security/

[2] http://readwrite.com/2014/01/29/google-artificial-intelligence-robots-cognitive-computing-moneyball

[3] http://www.xconomy.com/san-francisco/2010/06/14/the-story-of-siri-from-birth-at-sri-to-acquisition-by-apple-virtual-personal-assistants-go-mobile/

[4] See an example of how e-Passport gates are using biometrics to speed up the traveler's experience: http://www.accenture.com/us-en/Pages/success-london-heathrow-airport-automated-border-clearance.aspx

[5] For more on video analytics, see: http://www.accenture.com/us-en/Pages/service-video-analytics.aspx

[6] "What People Want (and How to Predict It)," by Thomas H. Davenport and Jeanne G. Harris, MIT Sloan Management Review, Winter 2009.

[7] This is sometimes referred to as the "uncanny valley." See http://spectrum.ieee.org/automaton/robotics/humanoids/an-uncanny-mind-masahiro-mori-on-the-uncanny-valley.

[8] Pew Research Center, August 2014, "AI, Robotics, and the Future of Jobs."

[9] "FT interview with Google co-founder and CEO Larry Page," by Richard Waters, Financial Times, October 31, 2014.

About the authors

Cyrille Bataller is a managing director, and the domain lead for Intelligent Computing, with the Emerging Technology group at Accenture. He leads Accenture's exploration of the Cognitive Computing field. Previously, he directed biometric identity R&D activities within Accenture Technology Labs.

Jeanne Harris is the former managing director of information technology research at the Accenture Institute for High Performance. She led the Institute's global research agenda in the areas of information, technology and analytics. Jeanne is the co-author of the business bestsellers "Competing on Analytics" and "Analytics at Work." Jeanne is currently on the faculty at Columbia University. She is based in Chicago.

Acknowledgments

The authors wish to thank the following people for their assistance in the research and preparation of this report: Adam Burden, Maysun M. Hasan, David Light, Craig Mindrum, G. Scott Phillips and Abigail L. Terrill

For more information

Contact cyrille.bataller@accenture.com

About Accenture

Accenture is a global management consulting, technology services and outsourcing company, with more than 319,000 people serving clients in more than 120 countries. Combining unparalleled experience, comprehensive capabilities across all industries and business functions, and extensive research on the world's most successful companies, Accenture collaborates with clients to help them become high-performance businesses and governments. The company generated net revenues of US$30.0 billion for the fiscal year ended Aug. 31, 2014. Its home page is www.accenture.com.

About the Accenture Institute for High Performance

The Accenture Institute for High Performance develops and publishes practical insights into critical management issues and global economic trends. Its worldwide team of researchers connects with Accenture's consulting, technology and outsourcing leaders to demonstrate how organizations become and remain high performers through original, rigorous research and analysis. For more information, please visit http://www.accenture.com/institute.

About Accenture Emerging Technology

Accenture's Emerging Technology group is responsible for incubating the next generation of Accenture's technology services. By partnering with Accenture Technology Labs, Emerging Technology Delivery and the Technology Industry Ecosystem, it provides expert services to identify, pursue and deliver advanced and emerging technologies with pioneering clients.

14-6130