Cognitive Computing and Big Data Analytics
By Judith Hurwitz, Marcia Kaufman and Adrian Bowles

CHAPTER
13

Emerging Cognitive Computing Areas

Cognitive computing is beginning to have an impact on a number of different industries. Initially, cognitive computing is starting to transform the healthcare industry, as discussed in Chapter 11, "Building a Cognitive Healthcare Application." Cognitive computing applications are already:

- Making and enabling new discoveries about patterns of symptoms that indicate specific diseases based on the power to read more research and case files than any individual physician
- Explaining the results of findings to medical students to help them refine their own diagnostic abilities
- Democratizing specialized knowledge and making it available to practitioners, who would rarely, if ever, see certain symptoms or conditions

All these capabilities that help drive the adoption of cognitive computing in healthcare will have the same potential in other industries. For example, finding patterns for disease diagnosis and making treatment recommendations are special cases of the general problem of identifying faults and remedies in complex systems. This capability to diagnose problems has applications in industries such as manufacturing—machine maintenance and repair from household appliances to oil rig apparatus, and even call centers for problem resolution. Evidence-based explanations that help to train new professionals can be used in any field where a large or complex body of knowledge is codified. Finally, almost every profession

has the potential to thrive by aggregating and analyzing specialized knowledge and packaging and selling that data as a service. Professionals ranging from lawyers to accountants and stockbrokers can be democratized by giving newly-minted professionals and inexperienced users the power to leverage this knowledge with the assistance of a cognitive computing guide.

This chapter identifies attributes of problem domains that make them well suited to similar transformations in other industries, and shows how some functional areas across all industries can also be transformed.

Characteristics of Ideal Markets for Cognitive Computing

At the heart of every cognitive system is a continuous learning engine that improves with experience and that can return probabilistic results when the data supports multiple candidate answers. Advanced systems make use of natural language processing (NLP) to capture meaning and nuances in text from publications. In addition, these systems can make use of images, gestures, and sound. The systems can increasingly capture streaming data from Internet-enabled sensors. Mapping this functionality to typical business workloads—datacentric tasks found within and across industries—reveals a set of attributes that make some problem domains well suited to cognitive computing applications.

Ideal candidates for cognitive computing include:

- Industries with rapidly increasing or changing volumes of domain-specific knowledge, which make presales advice valuable to buyers but costly to sellers. This would include areas such as retail, where products and offers change constantly, and travel, where options and opportunities change constantly.
- Industries where post-sales support/diagnostics—professional services—are cost centers or revenue opportunities due to complex products. This is especially important when staff turnover is high and changes in product data requires constant training. This includes virtually every industry currently using call centers, from retail to enterprise software support.
- Industries characterized by a lot of specialty knowledge or experience that is highly concentrated in a small group of experts. This includes many professions and complex product presales where configuration decisions are critical.
- Industries that traditionally follow a modern apprentice/intern model for training and certification. This would include most data rich professions such as law, medicine, and financial services.

- Industries in which best practices are known or knowable, and there is a wide variance between the best and least-effective practitioners in the field. (The top experts are differentiated from average performers by their ability to draw on personal experiences or recognize patterns that are unknown or too complex for inexperienced workers.) This would also include most professions.
- Industries in which the sudden availability of sensor data creates opportunities that cannot be exploited by conventional means. This includes industries from transportation to healthcare; wherever sensors can capture meaningful data where real-time analysis by experts has value, cognitive computing applications can be adopted.
- Industries in which success depends on discovering patterns in a large volume of data, particularly unstructured natural language text. Any field that produces a large stream of new research, beyond the ability of practitioners to absorb on their own, is a candidate. This includes most of the natural sciences, pharmaceuticals, and the professions (new case law around the world, changing regulatory requirements, and so on).

As a general rule, the introduction of cognitive computing systems can make an organization smarter by making the top performers more efficient. In fact, even the most sophisticated professional will not be aware of all the new findings in a field. A cognitive system prevents biases from driving decision making. It is quite common for the most experienced professionals to select an approach based on their own best practices without taking into account that there is new data that they have not been exposed to. Less experienced professionals can perform at a much higher level because they can benefit from the shared knowledge.

The cognitive system is not static. It is continually ingesting new information from data and from both successes and failures. The dynamic nature of this environment has the potential to raise the level of expertise of the entire organization.

Vertical Markets and Industries

This section looks at a few market segments that are already using advanced analytics to improve their performance, and have leaders exploring cognitive computing solutions. The intent is to show how the common characteristics are driving this adoption and acknowledges that there are many other fields with similar attributes and many proof-of-concept projects underway that will change the public perception of cognitive computing and create demand for smarter systems in almost every field.

Retail

Retail is a notoriously competitive industry. To survive and thrive, retailers have to anticipate what products to purchase based on forecasting trends in advance. They have to understand the impact of changing economic, social, and demographic factors. Retailers also have to make sure that their employees do a good job at both representing the company and the products sold. External factors can also wreak havoc with plans and forecasts. Unseasonable weather, changing gas prices, fluctuating employment rates, and even political unrest can impact buying behavior. Larger firms have used predictive analytics and scenario planning tools for decades. These firms have optimized supply chains to reduce the lag between ordering an item and delivery (lowering the risk of receiving out of fashion or unwanted goods). However, too often retailers miss subtle changes in buying preferences and do not anticipate opportunities to gain advantages over competitors. Cognitive solutions have the potential to help retailers leverage knowledge in inventive ways. For example, a typical large retailer relies heavily on its supply chain automation to deal with customer problems. These systems are weak when unanticipated problems arise. Being able to provide creative ways to deal with problems so that customers remain satisfied and loyal.

Cognitive Computing Opportunities

Many retailers use predictive analytics tools to detect interesting correlations to discover insights based on loyalty-card data. For example, analytics help retailers to recognize changing habits, buying preferences, and changes in life circumstances (marriages, pregnancy, and such). It is possible to differentiate between an anomaly and a true change in buying preferences. For example, a product may be suddenly popular because of a single event. (A sudden storm causes consumers to purchase snow shovels in a region that gets little snow.) With cognitive computing, these changes may be detected earlier, enabling the retailers to implement innovative new practices and approaches that can change the customer experience. Retailers will be more interactive with customers through natural language dialoging with high-value customers. These retailers will have the ability to learn from the information gleaned from social media and customer interaction with call centers. They will bring together all this data so that it learns from practices of the most successful sales personnel and from the most successful campaigns. Armed with this type of dynamic environment, a retailer could discover new approaches to retail that can change the relationship with customers. Even increasing sales from repeat customers by a small percentage can result in huge profits.

Personalized Customer Service

In retail sales, customers are constantly faced with new choices, features, or fashion and must decide which product to buy, when to buy, and from

whom to buy. Although recommendations from friends on brands and sellers are important, the customer experience in a store or on a website can make the difference between casual interest and an actual purchase. With that in mind, retailers struggle with the issue of how much personalized attention to provide for each shopper—sometimes sacrificing volume for higher margins. Buyers usually have to choose between stores that offer knowledgeable sales staff and those that don't, whether the purchase is made in a physical store or online. For higher-priced items, from luxury goods to complex home electronics, this creates a tension when good advice in a store often leads to an online purchase based on price. The promise of cognitive computing in this case is to democratize good advice. This requires that retailers offer personalized attention to a buyer's wants and needs by using extensive knowledge about the products. It also requires that retailers gain insights about those customers so that they can make recommendations that are meaningful. Taking advantage of a system that continuously learns and adapts based on collecting and analyzing massive amounts of data can make a huge difference between success and failure.

An early entrant into this market is Fluid, a 15-year-old firm specializing in building online customer experience tools for leading retailers. The company partnered with IBM (who announced an equity investment in Fluid) to build a Watson-based platform that enables customers to communicate with online retail sites to provide customized product recommendations. The goal of this service is to lead the buyer through a dialog that mimics the customer engagement of a personal shopper. Fluid's first customer is NorthFace, a retailer that offers hundreds of products for outdoor activities and caters to "explorers" who are willing to pay a premium for quality.

The Watson-based platform will enable customers to enter a natural language description of their requirements from "I need a sleeping bag for a trip to Argentina in May" to "What should I take on a camping trip with three young children?" By engaging in a conversation with the buyer, the system can leverage information in its corpus about each item in inventory, and each type of activity in its ontology (for example, from camping to hiking). Through this dialoging process, the system narrows the scope of suggestions based on a match between what is available and the knowledge it acquires about the customer from this conversation. The system also stores all the background information from previous customer interactions and queries. The system can also look for similar queries and outcomes from other customers. This is not the same as a simple recommendation engine that provides a series of potential options. In the Watson system, the user can generate questions based on the assumption that the system contains depth of knowledge. As the system collects more information about consumers over time, the level of confidence in those recommendations increases. Retaining information between sessions allows the system to learn from each interaction and provide better advice in subsequent sessions with the same or different users.

Retail Staff Training and Support

It is critical that in-store personnel provide consistently good advice based on product knowledge and good customer interaction skills. However, retailers typically have high turnover so that average salespeople lack deep knowledge about the products they sell. UK retail technology firm Red Ant commissioned a study of 1,000 retail workers aged 18–55 by an online polling firm. The results were revealing:

- 50 percent of respondents reported feeling embarrassed by their own lack of product knowledge
- 43 percent said they lie to customers every week due to product knowledge deficiencies
- 73 percent said they send customers to another store
- 57 percent said they were given less than 2 hours of training before being sent to help customers

The results clearly indicate that there is a critical need for training. Employees need to understand the products they sell and need access to best practices. Employees often quit or are fired under less than ideal working conditions. It was clear to Red Ant that there was an opportunity to use a cognitive approach to improve the performance of retail workers.

Red Ant specializes in helping retailers improve their processes through analyzing customer and retailer behavior. Therefore, Red Ant is developing a Watson-based retail sales-training application to market. The goal of the product offering is to help sales associates analyze customer demographics and purchasing histories. The application will provide access to product information and market feedback from sentiment analysis to help retail workers make better recommendations to customers. Bringing together customer information with product information while the customer is in the store will enable a more engaging dialog using NLP from Watson and will create a more personalized shopping experience for the consumer. Every interaction with that customer is recorded and can be compared with interactions with similar digital histories. This corpus of data is intended to help predict what will be most effective and record the results. The sales associate may get recommendations via custom on-screen prompts, which could be shared with the customer or via text-to-speech messages through an earpiece.

Travel

The travel industry has seen tremendous upheaval in the past two decades as information about rates and schedules of transportation, lodging, and leisure activities has been made freely available online. Self-service booking sites have enabled individuals to make their own reservations after searching multiple sites for descriptions, prices, and even reviews, without paying a fee, and other sites have emerged to harvest results from multiple sites with a single search.

That has eliminated the personal touch of an experienced travel agent who could get to know the customer and ask qualifying questions to ensure a good fit between personal goals and desires, and available inventory of transportation, lodging, and experience options.

Although much progress has been made in terms of making information visible, optimizing yield on flights and cruises based on predictive analytics and customer history, what is lost is a store of personal information about the *why* aspects of trip planning, and experience-based recommendations that understand the client's objectives. An individual may have different preferences for pleasure and business travel, and different preferences based on duration, location, and who is paying for the trip or even who is accompanying them, but no single site captures all this information today.

Cognitive Computing Opportunities for the Travel Industry

It was once common to work with a travel agent who could get to know the preferences of an individual and be on the lookout for new options and new opportunities. Today, the traveler typically has to provide a profile of standard options for each site they use. However, none of these sites provide inferences are made based on observable behavior. This leaves a big opportunity for a cognitive computing travel application that captures information explicitly by capturing patterns of travelers' behavior. There is also the potential for implicitly understanding travelers by monitoring social media streams. There is also an opportunity to allow travelers to interact via an NLP interface with the system.

An example of what you can expect is a company founded by Terry Jones, the founding CEO of Travelocity and an early chairman of Kayak. WayBlazer is a startup founded by Jones with the intention of leveraging cognitive computing services from IBM Watson to add evidence-based advice to its product. WayBlazer is also built on top of a cloud solution built by Cognitive Scale, a company that provides a cognitive-insight-as-a-service platform. The company is collaborating with the Austin, Texas Convention and Visitor's Bureau to create an application that will provide customized recommendations for individuals. Over time, the company intends to expand to provide concierge services to hotels and airlines to improve the overall user experience and provide additional revenue opportunities to these ecosystem partners. WayBlazer is using the NLP and hypothesis generation/evaluation capabilities from Watson to evaluate a corpus initially populated with data from the destination and transportation vendors (suppliers), but which will be augmented by knowledge it acquires by monitoring traveler requests and outcomes. In addition to earning the customary fees from transactions, the system can learn about individuals and group behavior. WayBlazer will collect valuable data that it will be able to sell to the suppliers. The travel industry is fertile territory for a cognitive approach and there will be many competitive services that will provide evidence-based advice to travelers.

Transportation and Logistics

Transportation and logistics companies face stiff competition, regulatory pressures, and danger from man-made and natural causes, from terrorism to tornados. Keeping the infrastructure safe is an ongoing concern. In addition, there is a need to identify patterns of customer behavior that may foreshadow new revenue opportunities. Logistics firms were among the first to optimize route times with such tricks as minimizing left turns in cities and improving yield with highly optimized hub and spoke terminals. The rise of sensor technology and GPS tools has uncovered further efficiencies, but we are now on the cusp of a new, smarter industry as cognitive computing technologies are applied across the board.

Cognitive Computing Opportunities for Transportation and Logistics

Many changes in technology are transforming the transportation and logistics industries that will be helped by processing and managing complex data. The first change is the rise in the use of sensor data that needs to be interpreted in near real time to identify opportunities to improve efficiency and safety. The second change is the capability of cognitive computing models to provide diagnostic and preventative maintenance recommendations. These recommendations will help make fleet operations and maintenance more effective. For example, these recommendations will help managers schedule preventative maintenance while minimizing disruption.

CSX, a 185-year-old transportation and logistics firm based in Jacksonville, Florida, has implemented this type of system. With more than 21,000 miles of railroad track, connecting virtually all the population and manufacturing hubs in the United States, CSX links more than 240 short line railroads and 70 water ports. The company replaced a manual-intensive track inspection system that required 600 road masters and track inspectors to record track condition information on paper. This information was then manually input into a system for analysis and reporting. The replacement system, called an Integrated Track Inspection System (ITIS), was developed by CSX leveraging analytics technology from SAP. ITIS replaced the manual system with more functionality and mobile access to recording and predictive analytics tools.

CSX and SAP are also developing a complementary planning system that uses natural language processing and sentiment analysis of unstructured customer feedback. Combining data from these systems into a single corpus with data about traffic patterns and sales data will enable CSX to identify new revenue opportunities in a continuous learning environment. As CSX increases its use of sensors to provide real-time data, integration of these systems will create more opportunities to make the lines safer and able to continuously learn from results. This learning will result in new best practices to improve the efficiency of CSX's operations.

Telecommunications

Telecommunications providers live and die by performance metrics that may be easy to measure but difficult to manage. Customers of these providers are often large companies that resell services to large companies of managed service providers. To be successful they have to provide a predictable level of service. They are often required to provide service-level agreements (SLAs), which specify required performance levels for service delivery. If the telecommunications vendor cannot deliver the service, there are often financial penalties. It is incumbent upon the provider to constantly monitor and manage performance and to demonstrate compliance with the SLA or quickly identify and rectify any subpar performance. Telecommunications providers have matured from providing voice communications channels and basic access to relatively static data, to streaming video to consumers on home and mobile devices, and responding to consumer demand for data on the latest mobile application. As the variety of services offered by telecommunications providers increases, so does variability in demand.

The requirement for continuous performance monitoring, which may have subsecond response time mandates, has led to the deployment of sensors and probes at the edge of the network that can give a real-time view of the actual service level available to the customer. Demand may change due to a variety of events ranging from routine maintenance to a sudden surge in demand because of natural disasters.

Cognitive Computing Opportunities for Telecommunications

Collecting all this data, even in real time, is the easy part. The hard part is to identify conditions that indicate an impending change in demand in time to reconfigure or reallocate services to ensure ongoing SLA compliance based on weak signals—patterns that have traditionally escaped the notice of even well-trained and experienced network engineers. This is where the benefits of cognitive computing come into play. The problem for telecommunications companies is to evaluate enough historical data to discover and understand patterns and causality, while evaluating signals from the environment about impending events that may trigger demand change.

Hitachi Data Systems has developed a solution aimed at helping telecommunication managed service providers monitor and manage real-time data using a combination of machine learning algorithms, proprietary and open source intellectual property, and third-party offerings integrated through APIs. Hitachi uses a component library built from historical customer data including spatial-temporal event detection, complex event processing, event extraction from unstructured data, and root cause analysis to augment the machine learning algorithms. The system continuously monitors current performance and compares it with historical

performance. The system also analyzes unstructured data such as social media streams (weather emergencies or a popular television event that is about to happen) that can impact network performance. By combining real-time data analytics with unstructured data analytics, the system can anticipate changes in demand based on patterns. With continuous learning at its core, such a cognitive computing solution could alert network engineers of impending demand, or even dynamically adjust capacity proactively to prevent a crisis.

Security and Threat Detection

Commercial network security is a concern for business continuity and general risk management in virtually every industry today. Networks, websites, and applications in the cloud are all attractive targets. Cyber-terrorism attacks made for commercial gain or simply to exploit vulnerabilities to demonstrate the proficiency of the attacker are on the rise and show no signs of abating. Even constant vigilance with conventional technology is not enough to keep up as attackers employ more and more sophisticated approaches to theft and disruption.

Cognitive Computing Opportunities for Security and Threat Detection

Following are three big drivers for adopting cognitive computing for threat detection:

- The speed at which new threats are developed
- The speed with which damage can be done before an attack can be controlled
- The complexity of networks that are getting beyond the capabilities of conventional systems and network managers to protect

In the past, as new threats were detected, new rules were rolled out to network administrators or individuals with subscriptions to security and antivirus packages. The delay between detection and updates could be hours, days, or weeks.

Fortunately, machine-learning solutions can monitor network access points continuously and compare current activity to historical activity while looking for anomalies—without being told what to look for. Instead of waiting for an update, the system can highlight unexpected activity patterns and even take actions such as quarantining data and network segments while an operator evaluates the situation. For a false positive (an anomaly that simply represents a new but safe activity pattern) the system can learn that the new pattern is benign and update its own knowledge so that future occurrences will be recognized as the new normal and not register as a threat.

The Cognitive Threat Analytics solution from Cisco is an early entrant in this market. It uses machine-learning algorithms to analyze traffic through a secure

gateway and look for symptoms—anomalous behavior—without concern for the method of attack. This eliminates the old loop that required threat identification as a first step. Cisco can build a corpus of normal behavior patterns by analyzing the activities of individual users and larger groups of similar users. When an unexpected pattern is found to represent a new, benign activity, the updated corpus can be made available immediately to all users of this cloud-based service. Looking at behavior within the network without the bias of rules that were constructed based on previous threats allows the system to learn based only on relevant evidence.

Other Areas That Are Impacted by a Cognitive Approach

Although several industries that can be helped by cognitive computing have been mentioned, many others are good candidates. In some of these areas projects are already underway. Other markets will adapt continuous learning solutions in the coming years. This next section indicates which areas will be impacted by a cognitive approach.

Call Centers

The call center is a cross-industry function that is critical to the reputation and management of an organization. The call center staff is required to have deep knowledge of products and customer issues. However, call centers have notoriously high rates of personnel turnover. When highly skilled staff members leave, their knowledge and best practices leave with them. There is enormous pressure to know intricate details about products and services and to provide the "next best action" to retain customers and sell them other products and services. In addition, call center agents must understand and comply with compliance requirements for their industries.

Cognitive Computing Opportunities

A considerable amount of data can be applied to creating a cognitive computing solution for call centers. Structured data exists in customer support databases. A considerable amount of data is available in notes and documents related to customer interaction and recommendations that can be added to a corpus for a call center application. Over time, the machine learning process can provide guidance for best practices for addressing customer issues. An NLP interface enables a customer support agent to determine next best actions. In addition, customers can interact directly with an online system to determine solutions without long waits on call center phone lines. Eventually, many inbound tasks—getting input from the customer—should be automated using NLP and hypothesis generation. The refined query can be handed off to a human for action or

may be handled directly by a cognitive call center application. (The system may determine whether the caller would prefer a human response by asking or by evidence from previous experiences with the same or similar customers.)

Solutions in Other Areas

A number of other areas exist in which work has started on creating cognitive computing solutions. These are all areas in which a large amount of both structured and unstructured data exists. Some promising areas include:

- **Financial services**—In a data rich environment such as financial services, it will be possible to gain an understanding of an individual's requirements and the best product offerings. The data will be put in context with a vast volume and variety of data from multiple customers. The cognitive system can learn based on patterns of success to provide best next actions.
- **Legal applications**—The legal industry is heavily focused on unstructured documents that include the details for discovery and compliance. This data comes from records ranging from e-mails to tweets to clinical trial results, which must be kept for years and made available upon demand. These legal activities may be carried out by in-house counsel or outsourced, but they all require electronic discovery. This often requires significant resources to scour relevant documents and filings that were created in unstructured natural language. Advanced NLP systems and pattern recognition algorithms found in continuous learning systems are ideal for these applications. Today, a common practice is to use the Electronic Discovery Reference Model (EDRM, from a coalition of attorneys, IT managers, and other interested parties). In the future, using a cognitive computing system could simplify the process, and people could also be trained to alert the business to new opportunities (investments that fit a profile, for example) or risks (scenarios that foretell legal action) by combining information from the company corpus with updated sentiment analysis of social media data and news feeds that indicate impending litigation before it is filed.
- **Marketing applications**—Most of the applications for marketing analyze results of existing campaigns or use predictive analytics to anticipate future customer requirements. The opportunity exists to actively monitor the information related to customer and prospect interactions. On the outbound side, message and pricing can be structured as hypotheses that can be tested against a corpus of data about the industry, firm, current clients and prospects, and competitors. A well-trained continuous learning system could evaluate alternatives and help marketers refine messaging and pricing by asking the right questions early in the process. Constant monitoring and updating of the corpus with relevant social media and

news items—using NLP—would add significant value to that process and to the monitoring of public perceptions of the brand. Sentiment analysis is already used in this context; the cognitive advantage would come from intelligent hypotheses and questioning from the continuous learning component.

Summary

Early cognitive computing successes in areas such as medical diagnosis, manufacturing fault prediction, and healthcare research have convincingly demonstrated the potential for continuous learning systems to change the way we think about entire industries. In the next decade, these learning systems will likely be applied in every industry or business functional area that is characterized by a rapidly increasing or changing volumes of domain-specific knowledge, a high concentration of specialty knowledge in a small group of experts that has great value to a broader audience, or ones that are undergoing great transformations where uncertainty—that is, there is not one single right answer in most situations—is the rule.

As the cost to deploy these systems becomes an operational rather than capital expense (for example, ecosystem revenue sharing models for cognition as service offerings) the barrier for entry will be lowered even further and adoption should increase rapidly. The trend to offer all sorts of functions as services has already transformed the SMB (Small/Medium Business) market in areas ranging from expense management to productivity suites to customer relationship management applications. The next wave of enterprise-level cognitive computing applications is on the horizon, and the cognition as a service wave for functional areas is not far behind.