

 WHITE PAPER

THE COGNITIVE STEP — HOW SEARCH WILL IMPROVE

"Cogito ergo sum ego meliorem"
"I think, therefore I am better"

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READ THIS IF...

You are a search manager or enterprise architect, or a C-level executive, charged with or concerned about improving information productivity in your organization, or if

- Recent search-based solutions have been running over budget, past deadline, and below user expectations, or
- Your user community is losing interest or confidence in existing search-based solutions, or
- You're finding the demand for new search-based solutions is growing faster than your ability to deliver

This paper describes a major shift being driven by increased demand and expectations among those who rely on search-based solutions. It details the essential technologies emerging that address the challenges of delivering answers in the era of Big Data.

"...I've got to admit it's getting better...A little better all the time"

Paul McCartney

AT A GLANCE

Things simply have to get better. Users seeking answers at work have been changed by their experience with a host of consumer technologies. Interactions with technology are becoming conversational. Search-based solutions are delivering answers, not reading lists or even documents.

A recent survey¹ by Findwise AB, an enterprise search consultancy reveals widespread concern – among IT and business professionals alike. Fully 40% of users in responding organizations registered dissatisfaction with existing search applications. And over 45% of surveyed organizations plan to replace existing search technology within the next 3 years.

Technologies for narrowing and accelerating the inquiry process have reached a new level of maturity. The result is a new ‘cognitive’ model for designing and implementing search solutions – one that relies upon the principle of ‘kaizen’, or continuous improvement. For example, several leading financial institutions use machine learning algorithms to analyze and reduce triggering of ‘false positive’ compliance alerts.

With the transition to the app economy nearly universal, the next frontier for search to explore involves technologies that make interaction more natural and more intelligent. Technologies and solutions that address and incorporate these objectives create a “cognitive step” for the future of search. Enumerating and evaluating them requires a subtle shift – from the perspective of search results to the process of finding answers.

FOUNDATION: SUPPLY AND DEMAND

The decisions that drive organizations are driven increasingly by concise and authoritative answers – in dashboards, reports, studies, and answers to ad hoc questions. So a natural place to start a review of search’s future is with an understanding of the fundamentals that determine the demand for and supply of answers.

¹ Enterprise Search and Findability Survey 2016, Findwise AB, Stockholm, Sweden

First, the demand for answers is what economists term a 'derived demand'. Here, demand is derived from the role they play in the production of decisions. The value of an answer comes from either an increase in revenue that flows from a decision an answer supports or by an increase in decision productivity caused by answers. Generally, better answers produce more precise, certain, or timely decisions.

Consequently, as the demand for decisions requiring answers increases, so do the price/value of decisions and the demand for answers. Factors that increase the demand for decisions, e.g. deployment of IoT-data applications, an increased pace of regulation, or increased uncertainty will increase the demand for and value of answer-producing activities.

Expectations in earlier generations of search technologies placed greater value (to users) and cost (to vendors) on providing larger, more comprehensive lists of potential answers – answers usually buried in ordered lists of documents. While comprehensive lists of search results might have sufficed in previous generations of search, today's users strongly prefer concise (single) and accurate (authoritative) answers.

This change reflects the generational shift underway in search. For every organization, this increasing preference or value for fewer, more authoritative answers (let's call this the precision effect) eventually overwhelms the value for more potential answers (call this the recall effect).

On the supply side, answers come from facts, the correlation of multiple facts, and logical combinations of facts and associated premises. If facts are difficult to establish, correlate, or argue, decision makers typically adjust their decision processes to incorporate answers that are probable or uncertain. In any event, decisions are made; decisions that produce outcomes for the organization.

Factors that influence the supply of answers include

- The breadth and ambiguity of the underlying question,
- The context, or supporting information, associated with each potential fact,
- The accuracy with which facts are identified,
- The certainty with which facts are identified
- The breadth of evidence sources, and
- The time-to-answer, or efficiency, of the answer generating process.

Narrowing the scope and ambiguity of inquiry, increasing the context of every bit of evidence, increasing search accuracy and certainty, widening the number of relevant evidence sources, and reducing the time-to-answer – as first-order forces, are indicative of innovation in search technology.

When the recall effect dominates, an increased demand for answers, e.g. caused by the generation of more data, will increase the number answers, and increase their unit-value. Correspondingly, an innovation in search technology, e.g. adding context to evidence, will increase the number and decrease the unit-value of answers.

However, when the precision effect dominates, the same increase in demand will produce fewer answers, each with higher unit-value. And an innovation in search technology will produce fewer answers and an increase in unit-value.

Table 1. Cognitive Search vs. Traditional Enterprise Search

	Enterprise Search	Cognitive Search
↑ Demand for Answers	# ↑ \$ ↑	# ↓ \$ ↑
↑ Technology for Answers	# ↑ \$ ↓	# ↓ \$ ↑

What can we infer about the changing role of search from this simple analysis of supply and demand? Three things. First, organizations can assess their ‘search maturity’ using the basic predictions of supply and demand. Second, the forces influencing supply and demand are also driving the emergence of cognitive search technologies. Third, the forces of supply and demand in cognitive search are working in concert for users and vendors – generating answers of higher value.

A Perspective: Making Search Great, Again.

QUESTION:

We've seen several generations of search software introduced into the enterprise. It seems that each new generation corresponds more to the product vision of vendors than something changing or developing in users. It reminds me of the Henry Thoreau quote; "Things do not change; we change." Is there a user-focused explanation for what's happening in search?

PERSPECTIVE:

Absolutely. And you can analyze it using the two concepts, the *precision effect*, and the *recall effect*. Earlier on in the history of search, the recall effect predominated – users expected and valued comprehensive lists of results containing answers. Eventually, their experience with other answer-generating applications shifted their preferences and sense of value to fewer, focused, authoritative answers – what we call the precision effect. Vendor responses like tunable relevancy models and more sophisticated query processing were tangible responses to customer preferences.

QUESTION:

When search became really smart on the Web and helped people become truly productive, the "consumer" searching experience rocketed past what they experienced at work. By comparison, most enterprise search products had a hard time keeping apace. Does this also relate to the concepts you call the *precision effect* and the *recall effect*?

PERSPECTIVE:

Much of the innovation in search technology in the past reflected the perception of users wishes – so yes, there is a relationship between those effects, as reflections of consumer preference and the efforts of platform and technology providers. The cumulative effect of the recall-precision transition has driven a shift in technology – so that increased innovation shifts the supply of answers to reflect higher value with fewer answers – directly the opposite of behavior when users were recall-focused. Technology today is well aligned with users – fewer, more precise answers with higher unit-value.

OBSERVATION:

So, your position is that the basic market forces of supply and demand are already working to make search better. And, that the clear shift to implementing new, or enhanced, capabilities into search platforms is a clear signal that it's happening. You've used the term 'cognitive' to describe the capabilities changing search. What common characteristics make them 'cognitive'?

THE ESSENCE OF COGNITIVE

What makes technology cognitive? Ultimately, the ability to learn from experience and adapt continuously to feedback is the hallmark of a cognitive technology.

Feedback from outcome, from context (data and user)

Various disciplines, like psychology and computer science, use the term cognitive to describe “...processes that acquire and understand knowledge through some combination of senses, thought, and experience”². Mapping key components of modern search platforms onto this working definition is the next step in our review.

In general, modern search acquires information through a limited number of ‘digital’ senses – notably text, numbers, and voice (though progress in machine vision may add images soon). As part of this acquisition process, search technology often analyzes, filters, and enriches information. When the experiences of ingesting information are used to guide or modify analysis, filtering, or enrichment – the acquisition process has become cognitive.

Similarly, modern search ‘thinks about’ the information it acquires and indexes when it performs analysis, correlation, and inference to identify and deliver answers to user questions. Some of this analysis may focus upon understanding the question more completely, e.g. using frequent synonyms for words that appear in the question. Much focuses upon matching answers to questions. And, some focuses upon how answers are presented back to users.

In each case, experience, and the learning it empowers, is the most differentiating element of cognition. Thinking, reflection, and analysis operate on the results of experience. Humans learn from experience - across endeavors as mundane as daily life and as noble as the scientific method. Machines, and the processes they control, can learn from experience, too. When the processes of analysis, correlation, and inference adjust to experience and outcome, understanding has become cognitive.

Specific to search, acquisition corresponds to deploying connectors that collect information from sources and the workflows that determine how each collected item is analyzed and enriched. While out-of-the-box (OOTB) connectors are important, a rich framework for modifying existing or creating custom connectors is a cognitive essential. The agility to adapt to change or opportunity is the reason why cognitive solutions will always dominate.

² “cognition - definition of cognition in English from the Oxford dictionary” www.oxforddictionaries.com Retrieved 2017-01-25.

Using information and the enhancements provided during acquisition, the operational technologies of search – indexing, query analysis, and retrieval – constitute the thought process envisioned by our working definition. Once again, models and algorithms that routinely process feedback (including decision outcomes) to adjust or rebalance key parameters are cognitive. Their ability to adapt, even without human intervention, increases the accuracy of the answers they produce. Explicit incorporation of feedback into these steps makes search cognitive.

MAKING SEARCH COGNITIVE

Mapping the forces of supply and demand back to cognitive search essentials, we can connect search innovation to those basic, inevitable forces.

There is always the opportunity to tune your search team, development methods, and technology - keeping a sharp eye on your ability to:

- **Combine content and data with widely different structures,**
- **The context, or supporting information, associated with each potential fact,**
- **Deliver extremely relevant results to app interfaces, rapidly**
- **Add new content, of any type, without disruption**

The future of search innovation is impossible to predict, but the focal points of current efforts are easy to enumerate. Earlier in this paper, six first-order factors determining the supply of answers were listed. For each factor, there is a corresponding cognitive search technology. The trend toward increasingly cognitive search reflects innovations in these technologies. Let's consider each factor-technology pair.

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- Technologies that support natural language processing (NLP) are directed toward reducing the breadth and ambiguity of user questions. NLP routinely employs text analytics technologies as part of its process to decipher meaning,
- Text analytics technology is essential for discovering context, or supporting information, associated with each indexed information item,

- Machine learning technologies that re-calibrate using feedback from decisions and outcomes improve the accuracy with which facts are identified and classified,
- Data connectors that swiftly add new evidence sources and machine-learning technologies increase the certainty, with which facts are identified,
- Data connectors and tools for adding new sources increase the breadth of evidence sources, and
- Platform technologies that support scalability, security, and agility reduce the time-to-answer, and increase the efficiency, of the answer generating process.

Enhancements to any of these technologies directly affect the supply of answers – increasing the ability to supply the answers users are seeking. For organizations whose users value the recall effect (more answers), search innovation will produce more (and likely more accurate) answers. On the other hand, if the precision effect dominates, innovation will produce fewer, more accurate answers.³

Practically speaking, most organizations, especially as they embark on their initial cognitive search projects, have a mix of users and appropriate solutions. Developing the ability to support a mix of recall- and precision-driven users will be a key element in the market for search for several more years. Consequently, factors such as scalability, security, ease-of-migration, and agility will likely play an important role as search continues to mature.

Revolutions in the cost of storage and computing have opened the door for analytic techniques (machine learning, text analytics, and NLP) that thrive and improve with large flows of data/evidence. As such, the emergence of cognitive search is inevitable – reflecting the combination of user expectations, search technology, and computing/data realities.

If your organization is evaluating its search solution portfolio, considering the interplay of these forces on each solution should be part of your search platform strategy. Like the proverbial genie, there's no possibility of returning to a pre-cognitive stage of search maturity. The trends in user expectations and technical possibilities point toward cognitive.

³ This 'dual' behavior is a reflection of what economists commonly term a backward-bending supply curve – a phenomenon commonly associated with the supply of labor (another economic good whose demand is 'derived'). This duality is precisely what creates the unique predictions in Table 1 above.

WHY COGNITIVE WILL WIN

Market forces are pushing toward common outcomes – more precise, higher value answers. No factors of comparable power or pervasiveness moving search in another direction. At a minimum, expect:

- Increasingly conversational user interfaces,
- Continuing refinements in deciphering context from evidence,
- More explicit linkage between analytics, answers, and decision outcomes,
- Increased speed of deployment and reductions in time-to-value,
- More direct, precise answers
- Renewed user engagement and loyalty

More Conversational Interfaces

Human understanding is largely conversational. Technologies like natural language processing (NLP) target the conversational paradigm to isolate precisely what an appropriate answer needs to be. Whether the conversation is mediated by text or speech, the future of user interfaces has shifted definitively, driven by everyone's experience with smartphones and tablets.

Engage your customers with interfaces that get to the heart of a question quickly and naturally. Better questions lead to superior answers. Friendly, comfortable interaction – like conversing with the virtual private assistant on your smartphone – will replace the 'single box' as the most common way to request answers. . Conversation is so much better than searching.

Your search platform must 'understand' conversation, support the addition of new content (and the context it delivers, too), and learn about you from the questions you ask.

Richer Context – Direct, Precise Answers

Correctly correlating evidence from structured and unstructured data starts with understanding the context of each data point. Detecting patterns and deciphering meaning involves text analytics, especially with unstructured information. Using a variety of techniques, including machine learning and statistical, modern analytics learn from feedback, adding cognitive power.

Incorporate text analytics during data ingestion, to perform NLP (see above), to support evidence correlation, and to detect similarities and differences – and your search solution will evolve with trends in users' questions. Context and learning combine to make answers more accurate and precise. In a world driven by answers, not documents, context differentiates solutions.

Make sure your platform provides multiple points to leverage text analytics and learning technologies. This is a good place to take advantage of known relationships between concepts, e.g. ontologies and taxonomies. Look for comprehensive APIs, a powerful universal index, and workflows to manage the steps from evidence collection to displaying answers

Learning From Outcomes

Answers shape decisions. Decisions produce outcomes. Historically, search solutions rarely linked answers and the outcomes they shaped. Today, solutions are connecting a 'cognitive' feedback loop – with the explicit objective of improving outcomes by tuning the components of search. Automated relevance tuning, using learning algorithms to analyze outcomes and suggest adjustments, completes the 'cognitive' process.

The manual burden of managing relevance was a hallmark of the pre-cognitive era of search. While such management produced better outcomes, the cost was prohibitively high for widespread use. Modern, cognitive search platforms automate the relevance management process, producing better answers, faster, and at lower total cost. And they scale much better than human-managed processes.

The heart of cognitive search is the ability to relate outcomes to the answer-generating process, and to adjust that process iteratively to produce precisely the answer needed.

Accelerated Time-to-Value

Getting the right answer and the best outcome are mission-critical. But doing so quickly is another reason why cognitive search solutions will win. The combination of rapid learning and automatable response are key factors. The ability to scale quickly and efficiently to changes in evidence sources insures that the other benefits of a cognitive approach extend across all evidence – providing a genuinely "holistic" perspective.

The explosion of applications on smartphones and 'phablets' further change the game. Connecting cognitive apps to those devices (and others) will make getting answers easier than ever, potentially time transparent. In an always-connected world, cognitive search – for all the reasons outlined above – will dominate.

Look for reliability, performance, relevance, and security – search apps have to support the full range of devices.

² <http://appirio.com/category/business-blog/2014/09/business-intelligence-what-to-do/>

Stronger Engagement and Loyalty

Improved answers, less frustrating interaction, and a solution that evolves with user experience are keystones to re-building engagement and satisfaction with search-based applications. Technologies that support learning, conversation, and a respect for user time by delivering answers, rather than documents or lists make answers more findable. Solutions with higher 'findability' will earn greater loyalty.

Search solutions build a strong association between questions and immediately useful answers. More frequent use, like practice, develops habits. Habits, in turn, reflect and drive loyalty. Just as organizations seek to attract loyal, repeat customers, search professionals can use a cognitive strategy to rebuild 'user equity' in their solutions.

The core capabilities of cognitive search are focused upon precision, certainty, and ease of use. These are the elements that will restore confidence in and satisfaction with search.

THINKING BEYOND COGNITIVE

The market-driven trend to cognitive exists in an increasingly integrated, global, and insecure world. Unified, scalable, global, agile, and secure operations are organizational imperatives driving search evolution, as well.

The arc of economic history bends strongly in the direction of increased integration, pervasive globalization, and increased competition. For these reasons, other elements will continue to contribute to the pace of search evolution. Most of these elements are present in one or more earlier-generation search platforms. The imperatives of enterprise readiness haven't changed; so cognitive search will need to co-exist in an enterprise setting.

Specifically, your cognitive search solutions should unify your current and future data architecture. Data fragmentation across applications, repositories, and silos reduces the value and increases the cost of discovering insight. Users forced to consult multiple, isolated solutions will waste time and lose interest. Unification that supports defining and provisioning correlated information from a single, universal index to multiple search or BI interfaces is the answer.

In a world fraught with tech-driven crime and insecurity, solutions that rely on an organization's most private evidence sources require comprehensive, flexible, and low-friction security.

Efficiently managing precisely what each user can view isn't just a matter of cost. For many organizations, it is essential to corporate survival.

Traditional search security frameworks fail in Big Data environments. Early-binding security (tag all content with access control information) collapses when new data sources are added or permissions are changed. Late-binding (checking all search results against user permissions) burdens security infrastructure and slows query response. Fortunately, a new 'active' security framework – one that stores access control information as separate relational structures in the search index – supports real-time, secure filtering of answers and permissions. Secure, enterprise-scale cognitive search warrants nothing less.

A third enterprise-grade capability in the must-have category is scalability. There are multiple dimensions to scalability, but here, we'll call-out three – the ability to expand resources linearly with growing use or data, the ability to expand globally across multiple languages, and a design that supports high-availability, high performance operation. Cognitive search that cannot scale will not improve the perception of search.

Finally, the platform for the future – cognitive search – should be future-proof, i.e. sufficiently open and extensible to remain compatible with changes in other IT components and standards. Acquisition, consolidation, and termination continue to haunt legacy search platform providers and their customers. To avoid the consequences, look for platforms that offer easily applied application interfaces for every workflow and analytic component. Your initial implementations will incorporate necessary and appropriate customization sooner. And, your cognitive search applications will adapt and accommodate as you modernize your data architecture.

Cognitive search, delivered at enterprise scale, fulfills the vision of those seeking answers and the mission of technologists seeking to solve increasingly complex information. It can support better decisions and actions that improve business outcomes. It can adapt and lower the barrier between people and machines, providing a rich opportunity for innovation.

CONCLUSION: START NOW

Enable IT search teams to achieve the transformations that accompany the implementation of cognitive search. Superior time-to-value opportunities to deliver the benefits of cognitive, secure, and enterprise-scalable solutions are currently available. Deploying a common, agile platform can drive knowledge management, create holistic perspective, and integrate modern communications in new ways, to increase efficiency and seize opportunity.

Don't be intimidated; implementing and enhancing cognitive components is already underway in many organizations, producing tangible, measurable benefits. Indeed, one of the principle hallmarks of deploying a cognitive search architecture is the explicit measurement and use of outcomes to tune models that feed retrieval algorithms.

As you upgrade search to a more cognitive footing, look for benefits in four principal areas. Analyzing all of the right information in context, you will mitigate risks and seize more opportunities – acting with greater certainty. Discovering more insights faster, you will bring better offerings to market, more efficiently – driving innovation. Accelerating search and discovery, you will optimize processes and decision making – transforming productivity. And, delivering precisely contextualized information directly to the point of need, you will improve business outcomes.

Over the next five years, search will rapidly transform in a continuing effort to mimic the very human trait of cognition. It will connect us instantly to all of the right information. It will infer meaning and reveal relationships with increasing accuracy. It will provide answers across broad, secure domains of users - efficiently. And it will be instrumental in delivering faster time-to-value for all who seek answers.

The future will belong to the cognitively advantaged. Communities of answer-seeking professionals will once again relish the process of learning and discovering. Most importantly, the promise of data and the benefits of analysis will become a possibility for all.

ABOUT ATTIVIO

Attivio is the leading cognitive search & insight company. Our Fortune 500 clients rely on us to drive innovation, operational efficiencies, and improve business outcomes. Our solutions provide industry-leading natural language processing, machine learning, analytics, and knowledge graphing capabilities at scale. We have a proud, rich history of boosting productivity by expediting search & discovery, personalizing customer interactions by delivering highly contextualized information at point of need, and minimizing enterprise inefficiencies by dramatically accelerating business processes. Attivio provides immediate visibility to all the right information so you can boost your enterprise's IQ, make better decisions company-wide, and seize every opportunity. Let Attivio empower you to act with certainty.

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