PROSPECTS OF COGNITIVE COMPUTING RESEARCH

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ABSTRACT: Cognitive computing (CC) makes a new class of problems computable. It addresses complex situations that are characterized by ambiguity and uncertainty; in other words it handles human kinds of problems. In these dynamic, information-rich situations data tends to change frequently, and it is often conflicting. The goals of users are to be redefined with their objectives. The understanding of the problems due to the cognitive computing system offers not only a synthesis of information sources but of influences, contexts, and insights. To do this, systems often need to be weighed for conflicting evidence and suggest an answer which is "best" rather than "right". The purpose of this paper is circumvent the knowledge and the tools necessary to forge ahead with using and innovating in cognitive computing.

Keywords: Cognitive computing, mathematics for cognitive sciences, cognitive technology.

INTRODUCTION

As we advance into the future human beings are trying to make use of the automation and machine intelligence for making life more comfortable and aid in decision making. Though more sophisticated decision making algorithms are available but the challenges encourage investigations in designing highly intelligent systems and software.
Cognitive computing (CC) is a new type of computing with the goal of creating accurate models of how the human brain/mind senses, reasons, and responds to stimulus [17].

Cognitive computing (**CC**) makes a new class of problems computable. It addresses complex situations that are characterized by ambiguity and uncertainty; in other words it handles human kinds of problems. In these dynamic, information-rich situations data tends to change frequently, and it is often conflicting. The goals of users are to be redefined with their objectives. The understanding of the problems due to the cognitive computing system offers not only a synthesis of information sources but of influences, contexts, and insights. To do this, systems often need to be weighed for conflicting evidence and suggest an answer which is "best" rather than "right".

Computers are getting smart enough to provide supplemental processing power and contextually relevant assistance. Natural-language reasoning, predictive analytics and artificial intelligence are all advancing quickly.
Cognitive computing systems redefine the nature of the relationship between people and their increasingly pervasive digital environment. Their output may be prescriptive, suggestive, instructive, or simply entertaining. CC hardware and applications strive to be more affective and more influential by design.
One may have to find the analogies and differences between Cognitive Computing and Artificial Intelligence, as well as misunderstandings about semantic processing, natural language processing,

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decision automation, cognitive science, computational intelligence, machine learning, statistical intelligence modeling, cognitive simulation, and a host of other terms. Cognitive Computing is an umbrella term that throughout its long history has in one way or another encompassed.

With the advent of cost-effective big data technologies, it has become practical for businesses and research group of all sizes to have access to enormous volumes of data as well as to the computational resources required to process them. This has changed the way that computers interact with humans, particularly in the way that computers now can emulate human performance and competence in a number of tasks in ways that were only previously possible in science fiction stories. What is not well known is that there is an broad collection of methods for building these systems which range from extremely simple to highly sophisticated.

HISTORY

The first underpinnings of modern Cognitive Computing date back to the late 19th century, with the work of mathematician George Boole and his book 'The Laws of Though*t*', and the ideas of Charles Babbage on creating what he termed an "analytical engine." The term Artificial Intelligence (AI) was coined by the late John McCarthy in 1955 when he defined AI as "the science and engineering of making intelligent machines."

Of course the study of AI includes other disciplines such as psychology, neuroscience, linguistics, mathematics, logic, computer science, perception, natural language processing. Then on May 11, 1997 the world's imagination was captivated when IBM's Deep Blue beat Garry Kasparov, the current world chess champion. Also in 2005, Stanford-built robot and won DARPA Grand Challenge. Again in 2011, Watson defeated two of the greatest *Jeopardy!* champions without being hooked to the Internet. In fact ideas about thinking machines date back to ancient history, when Greek mythologists imagined such artificial devices as Hephaestus' bronze robot Talos, automatons of Hero of Alexandria, and the carved ivory statue Galatea that came to life in Ovid's retelling of Pygmalion.

Such grand creations have long been the purview of human imagination. But only in the past 30-40 years the reality of Cognitive Computing started to manifest in our daily affairs. According to Dharmendra Modha, the Manager of Cognitive Computing at IBM Research:

"Cognitive computing goes well beyond artificial intelligence and human-computer interaction as we know it–it explores the concepts of perception, memory, attention, language, intelligence and consciousness. Typically, in AI, one creates an algorithm to solve a particular problem. Cognitive computing seeks a universal algorithm for the brain. This algorithm would be able to solve a vast array of problems." In order to achieve this new level of computing, cognitive systems must be [17].

1. Adaptive. They must learn as information changes, and as goals and requirements evolve. They must resolve ambiguity and tolerate unpredictability. They must be engineered to feed on dynamic data in real time, or near real time.[2]

2. **Interactive.** They must interact easily with users so that those users can define their needs comfortably. They may also interact with other processors, devices, and Cloud services, as well as with people.

3. **Iterative and stateful.** They must aid in defining a problem by asking questions or finding additional source input if a problem statement is ambiguous or incomplete. They must "remember" previous interactions in a process and return information that is suitable for the specific application at that point in time.

4. **Contextual.** They must understand, identify, and extract contextual elements such as meaning, syntax, time, location, appropriate domain, regulations, user's profile, process, task and goal. They may draw

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on multiple sources of information, including both structured and unstructured digital information, as well as sensory inputs (visual, gestural, auditory, or sensor-provided).
Cognitive systems differ from current computing applications. As we move beyond tabulating and calculating based on preconfigured rules and programs. The term cognitive technology to describes how electronic devices and other tools can assist and influence humans' mental activities, such as learning, retaining and retrieving information from memory, and problem solving.

Of course Cognitive systems are helping chefs combine existing ingredients to create brand new recipes. Similar systems can help cook up new ideas for designers, developers, marketers... everyone.
`Can computers think like humans and help diagnose problems? Eric Brown of IBM Research discusses the new intelligence that is going to take healthcare into smarter directions..
The goal of cognitive computing is to get a computer to behave, think and interact the way humans do. In 5 years, machines will emulate human senses, each in their own special way.
Confirmation bias, loss aversion, the halo effect – inherently, humans face obstacles to making rational decisions. In the future, could purely logical cognitive computers help erase these mortal blind spots? Dario Gil explores what the future of cognitive computers looks like and considers the uneasy question: could technology ever replace humans? By Basit Chaudhry, Medical Scientist & Lead Research Clinician for Watson, IBM
We often believe that a system that *thinks* can, or will, help us make decisions. A cognitive system is supposed to understand, perceive and solve problems -- basically *think*. But this capability is made possible by a complex web of connected memories and knowledge acquired by the limitation of our respective "umwelts" (one's surroundings or environment - the outer world as perceived by organisms within it). What gives humans the ability to be cognitive entities is our brain's ability to connect all these stimuli and transform them into the concepts, which we exploit in everyday life to further feed our awareness and guide our decisions as we evolve.
When IBM introduced its groundbreaking cognitive technology Watson to the general public in 2011, the imagination of developers and technology visionaries went wild with speculations of the *2001: A Space Odyssey*'s HAL 9000 being amongst us. Predictions, expectations and notions of being able to expose the insight of customers from their web footprints, providing ubiquitous access to the cognitive transcendence of experts on the cloud, are becoming the reality of blue sky opportunities powered by IBM's next generation strategy. Inspired by our sci-fi pop culture, I don't think any other computing evolution since the internet has inspired as much imagination for the potential paradigm shifts in future human cognitive augmentation.
As IBM is leading a new era of computers, there is no doubt that Big Blue has struggled to gain traction and adoption. It is partly caused by our sci-fi driven expectations. If we can have 80% of the gadgets invented on *Star Trek*, why can't IBM give us 80% of a cognitive companion? The fact is these *Star Trek* inspired gadgets are physical accelerators of time and space as they facilitate physical transfer of information or objects (transporter excluded thus far).
Cognitive computing, and this is its biggest handicap, has to reach and be on par with our own concept of actual cognition as its judge in order to be accepted. This is a difficult task when it is these computational methods that are equipped with an abstract layer of assumptions and deterministic semantic models. Basically, it is not organic.

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Human cognitive awareness is found in our inner environment. It is a construct of abstract thus-far-undetectable connections and correlations which do not struggle with the physical constraints of speed, but rather with access to an evolving and impalpable knowledge corpus. Now that I have heated the kitchen to a point where one should close this page and go out to breathe and meditate on the simplicity of life, ok, now let's be pragmatic and realistic about cognitive computing. Is IBM headed in the right direction? Absolutely! Is the cognitive platform ready? Never. It is the nature of the beast. It will always have to evolve and catch up with humans, even if computing power reaches singularity because it has to interface with us.

So where do we start using this cognitive computing? First, we have to accept that we have been doing it already in gaming, analytics, workflows, semantic curation, and other programming interpretation layers beyond storage, communication and DBMS systems. What *is* changing is the computing power and frameworks available for us to improve upon these applications.

The fact is we can benefit from IBM's Bluemix's suite of tools to improve and include more of our know-how into our systems. I believe that 90% of cognitive computing applications will remain in this space of productivity. The other 10% will take it to the next level by implementing learning systems capabilities to improve resilience and improve just-in-time decision making with more artificial or human-enhanced insight.

How do we use cognitive technology? Our company specializes in revealing and detecting the patterns found in information streams. We do this by using organic-inspired algorithms to avoid the bias of deterministic semantic interpreters. We use mathematical models over natural language interpretation. Our algorithm has been doing this since 2007 with success in demonstrating that, with the help of Big Data computing, we can, in fact, reveal patterns of unstructured information.

What excites us about cognitive computing is that we can now build interpretative and learning layers on top of our organically-curated corpus of patterns. Simply put, we can tell that what themes and conceptual clusters have been emerging in real-time. And now with different IBM's Bluemix tools we can extract the personalities, the semantic concepts buried in the details. We can extract and correlate the objects found in images, extract summaries of complex texts, identify languages, or even build a QA interface to query a corpus of new content with natural language. We can build solutions with modules that help us gradually build cognitive capability. As an IBM business partner in this field of expertise, we can help our clients identify pragmatic and evolutive use for cognitive computing. Our company's name is about classification through temporal observation (Darwin), and the understanding of disruption and equilibrium within a business and its culture (Ecosystem). Cognitive computing can be a revolution, but it should be an evolution.

Jorge Garcia (**@jgptec**) [2], Senior BI and Data Management Analyst at Technology Evaluation Centers, agrees with that assessment. "Machine learning, along with many other disciplines within the field of artificial intelligence and cognitive systems, is gaining popularity, and it may in the not so distant future have a colossal impact on the software industry." The software industry is not the only economic sector that will feel the impact of cognitive computing — virtually every sector will.

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DeLoitte analysts, Rajeev Ronanki (**@RajeevRonanki**) and David Steier (**@dsteier** say: "Cognitive analytics offers a way to bridge the gap between big data and the reality of practical decision making." They explain: "For the first time in computing history, it's possible for machines to learn from experience and penetrate the complexity of data to identify associations. The field is called cognitive analytics™ — inspired by how the human brain processes information, draws conclusions, and codifies instincts and experience into learning. Instead of depending on predefined rules and structured queries to uncover answers, cognitive analytics relies on technology systems to generate hypotheses, drawing from a wide variety of potentially relevant information and connections. Possible answers are expressed as recommendations, along with the system's self-assessed ranking of how confident it is in the accuracy of the response. Unlike in traditional analysis, the more data fed to a machine learning system, the more it can learn, resulting in higher-quality insights."

There are a number of cognitive computing systems currently touting their capabilities. The most famous, of course, is IBM's Watson. My company, Enterra Solutions®, also has a platform we call the Enterra Enterprise Cognitive System™ (ECS), a system that can Sense, Think, Act, and Learn™. Although most cognitive computing systems use a combination of machine learning, mathematics, and natural language processing, there are differences. Watson basically uses a brute force approach to cognitive analytics. It analyzes massive amounts of data and provides a "best guess" answer (IBM calls it a "confidence-weighted response") based on what it finds. That's how Watson beat human champions on the game show *Jeopardy*! This brute force approach is often called deep learning. At Enterra, we take a different approach. The ECS uses various techniques to overcome challenges associated with most deep learning systems. Like deep learning systems, the ECS gets smarter over time and self-tunes by automatically detecting correct and incorrect decision patterns; but, the ECS also bridges the gap between a pure mathematical technique and semantic understanding.

The ECS has the ability to do math, but also understands and reasons about what was discovered. Marrying advanced mathematics with a semantic understanding is critical — we call this "Cognitive Reasoning." The Enterra Enterprise Cognitive System approach — one that utilizes the best (and multiple) solvers based on the challenge to be solved and has the ability to interpret those results semantically — is a superior approach for many of the challenges to which deep learning is now being applied. Ronanki and Steier add, "Cognitive analytics can push past the limitations of human cognition, allowing us to process and understand big data in real time, undaunted by exploding volumes of data or wild fluctuations in form, structure, and quality."

Jennifer Zaino (**@Jenz514**) asserts, "Cognitive Computing increasingly will be put to work in practical, real-world applications. The industries that are adopting it are not all operating at the same maturity levels; there remain some challenges to conquer. The wheels are very much in motion to make cognitive-driven Artificial Intelligence (AI) applications a key piece of enterprise toolsets."[4] Zaino reports that at a conference held earlier this year, Matt Sanchez, founder and CTO of Cognitive Scale, told the audience that companies "must leverage Cognitive Computing to bring contextual insights and advice right to the knowledge workers when it is needed so they can take action."

It may be noted that cognitive computing systems use natural language processing, they make analyses available to all those who need that capability and they don't need to be data scientists to benefit. In fact, Ben Rossi [5] (**@BenRossi89**) asserts that one of the most important benefits of cognitive computing is that it makes smart people even smarter. "In the past," he writes, "change has typically been based on

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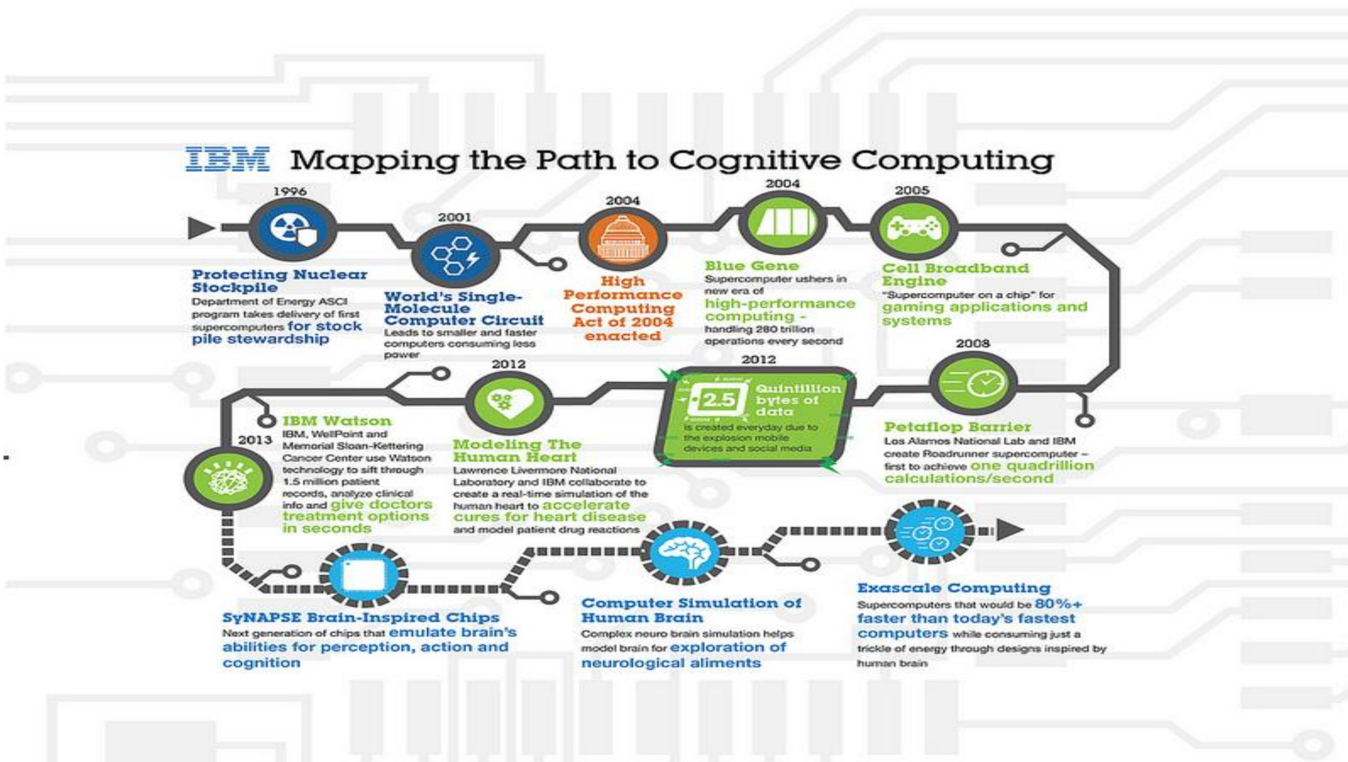
technologies that make us faster and more efficient. We're now entering a time of change where intelligent technologies are going to make us smarter."[5] Rossi notes that cognitive computing systems "empower business users with the ability to ask questions and immediately get answers without ever having to think about what the machine is actually doing."

Cognitive technology encompasses not just electronic gadgets, but a range of other things that can assist human thinking, from pharmaceuticals to brain-training games. Cognitive technology is a tool for describing our thoughts and also influences the way we think [source: Dascal]. As cognitive technology researchers Itiel Dror and Stevan Harnad explain: "Cognizers can offload some of their cognitive functions on to cognitive technology, thereby extending their performance capacity beyond the limits of their own brain power".



Recently IBM's Institute for Business Value, identified four steps that organizations should consider in moving forward with cognitive computing. They are: 1) Chart the course of organization's cognitive journey where in one defines the cognitive computing solutions desired to address priority cases and commit to a strategy. Develop organization's cognitive computing roadmap, which should also include a clearly defined change management strategy, by addressing plans for governance, organizational communications and benefits tracking. Also they must take stock of the business benefits cases which helps in defining key metrics to track the value of each use case.

2) Experiment must be designed to validate organization's cognitive strategy. Obviously innovation requires experimentation. This step is focused on testing, verification and validation of organization's

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cognitive use cases through prototyping. The purpose of developing a prototype is to allow users to see what the end state of their developed design treatments and focusing on the workflow for the use case scenarios. This is a critical step in validating and refining use cases. This increases user understanding and testing of the underlying business case hypotheses.

3) Develop solution and train the team**.** With a cognitive vision and strategy clearly defined **and vetted with** key stakeholders. Now it is time to begin implementation, where the real work begins and investments in human resources and the core technology are required. The focus of this step is to develop the solution bases on priority use cases defined earlier. Investments will be driven by the requirements and analysis conducted in the prior steps.

4) Deploy the solution and continue to evolve the organization's cognitive capabilities. Deployment of the organization's cognitive computing solution is just the beginning. Once the solution is deployed, even greater learning can begin for the system. This includes deploying the solution into and organization's operations, continuous learning (for the system, its users and stakeholders), continuous improvements, and exploration of further use cases for the application of cognitive computing in the organization. Continuous tracking of business benefits and accuracy levels is critical to assess and evaluate progress against key metrics.

As an organization moves toward a cognitive future, it's important to remember that cognitive computing is a journey — and that journeys evolve opportunities for cognitive computing. Thus organizations which move forward with this innovative capability will have the opportunity to push new boundaries for growth and gain advantage over their competition.

TRAINING AND FOUNDATIONS: Cognitive computing involves self-learning systems that use data mining, pattern recognition and natural language processing to mimic the way the human brains work. The goal of cognitive computing is to create automated I.T. systems that are capable of solving problems with out requiring human assistance. Cognitive computing is used in A.I. applications. Therefore Cognitive Computing is a subset of Artificial Intelligence. Cognitive Computing systems may include the following ostensible characteristics: 1. Natural Language Processing, 2. Machine Learning, 3. Algorithms that learn and adapt, 4. Vision-based sensing and image recognition, 5. Spatial and contextual awareness, 6. Reasoning and decision automation, 7. Sophisticated pattern recognition, 8. Neural Networks, 9. Semantic Understanding, 10. Noise Filtering, 11. Common Sense, 12. Robotic Control, 13. Emotional intelligence. The key characteristics are -

So basically, one can say that a cognitive computing system might be trained by The range of formal modeling approaches and their applications to understanding core areas of Cognitive science topics will include: Concept Learning and Categorization, Reasoning about Natural Kinds, Learning Causal Relations, the Structure and Formation of Intuitive Theories of Physical, Biological and Social Systems, The Acquisition of Natural Language (syntax and semantics), Theory of Mind: How we Understand the Behavior and Mental States of Other People, Formal modeling topics will include:, Bayesian Inference and Hierarchical Bayesian Models, Frameworks for Knowledge Representation: First-order Logic, Formal Grammars, Associative Networks, Taxonomic Hierarchies, Relational Schemas, Probabilistic and Causal Graphical Models, Relational Probabilistic Models, Controlling Complexity: Minimum Description Length, Bayesian Occam's Razor, Nonparametric Bayesian Models, Inductive Logic Programming, Sampling Algorithms for Inference in Complex Probabilistic Models. The syllabus will balance presentations of state-of-the-art material with a broad historical perspective.

Prerequisites: The pre-requisite is a class in probability or statistics, Statistical Methods in Brain and Cognitive Science, Introduction to Probability and Statistics, , Probabilistic Systems Analysis and

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Applied Probability . Experience in programming, particularly in a high-level language such as will be very helpful.

MATHEMATICS NEEDED

These areas of mathematics can be formally studied in a cognitive science major and can support the study of brain. Some areas that seem relevant would be: mathematical logic, graph theory, linear algebra. The network science being used in these fields.

Here's a list of mathematical subjects that support the study of brain (from a computational neuroscientist's perspective): Linear algebra, to understand high dimensions, to compute things quickly, foundation for other mathematics tools like Calculus, basics for everything continuous valued, Statistics to analyze any data, we need statistics, basis for modeling, regression, clustering, classification, and all Differential (basis for dynamical system), Dynamical system intuition for neural dynamics (deterministic equations approximation), modeling single neuron, synapse, small network, Statistical physics , modeling large scale noisy neural dynamics, Information theory, quantify how much "information" is coded in neural signal.

Again more mathematics subjects which would be most useful are Numerical computation, data and algorithm needs to be implemented in a computer, Convex optimization, statistics/model requires optimization, Probability theory (basis for stochastic process and statistics), Stochastic process, model of neural signals, decision process (diffusion), basis for advanced statistics, point process theory is useful for dealing with neural spike trains, Time series analysis (data is a time series!), Signal detection theory, psychophysics is often designed to be a detection task, Brain is quite noisy and we need tools to deal with noise.

More applied math than pure math is needed. I have only seen topology being used a handful of times and they were not very useful nor impressive. I love set theory and mathematical logic, but sadly , never used it nor seen it being used. In addition, real/complex/functional analyses are also useful, just in general.

.A graduate lecture course covering fundamental mathematical methods for analysis and modeling of cognitive and neural data and systems. The course was introduced in Spring of 1999, became a requirement for CNS doctoral students in 2000, and for Psychology doctoral students in the Cognition and Perception track in 2008. The course introduces a coherent collection of mathematical and statistical tools, providing a clear statement of assumptions, motivation, intuition, and simple derivation for each, but without insistence on rigorous mathematical proof. Concepts are reinforced with extensive computational exercises in the MATLAB programming language. The goal is for students to understand how to use and interpret these tools.

Topics include: Linear algebra, least-squares and total-least-squares regression, Eigen-analysis and PCA, linear shift-invariant systems, convolution, Fourier transforms, Nyquist sampling, basics of probability and statistics, hypothesis testing, model comparison, bootstrapping, estimation and decision theory, signal detection theory, models of neural spike generation, white noise (reverse-correlation)

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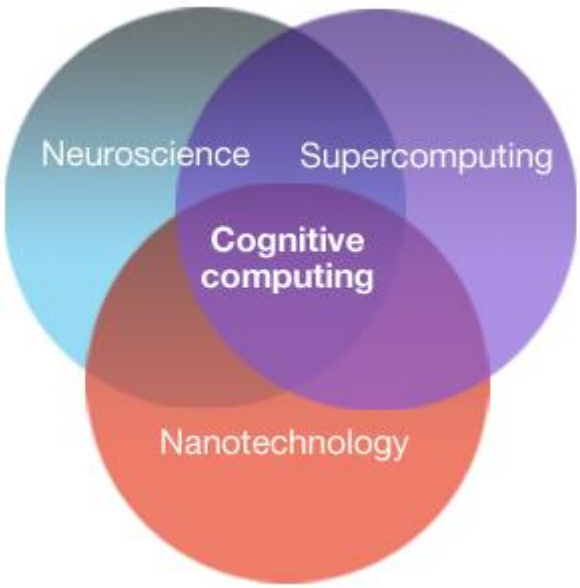
analysis.

Prerequisites: Algebra, trigonometry, and calculus. Some experience with matrix algebra and/or computer programming is helpful, but not required. The *real* prerequisite is an aptitude for logical and geometric reasoning, and a willingness to work hard.



CONCLUSIONS

Cognitive computing is real and is about to become very mainstream. As with all technology, it is what we make of it, which will define our future. CC application must have intent, memory, foreknowledge and cognitive reasoning for a domain of variable situations. These 'cognitive' functions are in addition to the more fixed page displays now found in most paging applications.

Cognitive computing is an emerging paradigm of intelligent computing methodologies and systems that implements computational intelligence by autonomous inferences and perceptions mimicking the mechanisms of the brain. It is emerged and developed based on the trans-disciplinary research in cognitive informatics and abstract intelligence. There are many open problems to be addressed and to be defined. The special session on Cognitive Computing and Applications provides a forum for researchers and scientists to present and share their latest research findings in this emerging paradigm**.** The era of cognitive computing: Calling for a shared research agenda, is 'Cognitive systems will require innovation breakthroughs at every layer of information technology, starting with nanotechnology and progressing through computing systems design, information management, programming and machine learning, and, finally, the interfaces between machines and humans. Advances on this scale will require remarkable efforts and collaboration, calling forth the best minds—and the combined resources–of academia, government and industry.' -- Zachary Lemnios,, Vice President, Strategy, IBM Research. We need to explore how social business, data analytics and cognitive computing will transform organizations**.** The next revolution in data analytics and knowledge management is related to cognitive computing says Judith Hurwitz

MIT's Thomas Malone on collective intelligence states that *"*The combination of people and computers will be able to think in a way that neither people nor computers have ever done before. I think that's the really exciting potential and opportunity for us ahead.*"* The future of Cognitive Computing**. --** Stephen F. DeAngelis.

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In the future course more diverse reasoning strategies would emerge on the fly strategies to address new problems Unsupervised deep-learning and self-reinformcing adaptive training models, less reliance on curated training data,; new channels of sensory communication related to speech, visual, and anthropomorphic animation also are in the offing. Jerome Pesenti [16], lead developer of IBM's Jeopardy-winning Watson supercomputer, says development of software relying on natural language and machine learning needs new ways of gathering and treating data; who also made a presentation of Cognitive computing on TEDx.

Watson Analytics, IBM's new tool that gives business users access to powerful analytics at their fingertips? Uncover the genesis and development of the new tool with IBM Experts, Thomas Dong and Kyle Weeks. Watch as big data experts Miles Austin, Lillian Pierson, Tim Moran and Thomas Ciszek discuss first-hand experiences with the new solution and share their impressions with the IBM team.
Dr. John Kelly of IBM Research has focused on the company's investments in several of the fastest-growing and most strategic parts of the information technology market, including IBM Watson. The Watson team is charged with accelerating a new class of cognitive software, services, and apps that fuel an ecosystem of enterprises, academic institutions, and entrepreneurs, during October 2015.

Zaino indicates that one of the concerns potential cognitive computer users have is trust. She explains: "Another thing to contend with in driving a growing use of cognitive-based applications is the issue of trust. How can businesses and their end users be assured that the cognitive system they are relying on can be trusted to recommend appropriate options or answers to them, or even that the systems are autonomously acting correctly on their own initiatives?"
That's a concern because some cognitive computer systems conduct "black box" analyses (i.e., they provide insights and recommendations but explain how they reached those conclusions). The Enterra ECS, on the other, can show the reason behind its recommendations and insights. That helps users gain trust in the system. Rossi observes that when cognitive computing systems are implemented correctly, they create a beautiful partnership with humans. "The machine is doing what it does best: reviewing massive data sets and finding patterns that indicate different activities and situations. And, humans are doing what they do best: looking at the situation, fitting it into a larger context and then responding to it appropriately." IBM Fellow Robert H. High Jr. told a conference audience earlier this year that "business computing will change from transaction processing to cognition processing" over the next decade.[6] .

REFERENCES:

1. James MacLennan, **"**The Next Big Thing," *Smart Data Collective,* 3 November 2014.
2. Jorge Garcia, "Machine Learning and Cognitive Systems: The Next Evolution of Enterprise Intelligence (Part I)," *Wired*,July,2014.
3. Rajeev Ronanki and David Steier, "Cognitive Analytics," Deloitte University Press, 21 February 2014.
4. Jennifer Zaino, "Cognitive Computing, Artificial Intelligence Apps Have Big Future in the Enterprise," *Dataversity,* 17 September,2015.
5. Ben Rossi, "How artificial intelligence will make humans smarter," *Information Age,* 25 November 2014.
6. Frank Tobe, "Cognitive computing will be to computing what transaction processing is today," *The Robot Report*, 9 October 2015.

ISSN: 2278 – 7798

7. Video lecture on IBM Discusses Cognitive Computing with the Computer History Museum, http://ibm.co/150psF0. June, 2013**.**
8. The Future of Cognitive Computing: Business, Consumers, Technology, and Academics, IBM Watson**,** May 13, 2015**.**
9. The Fifth Annual California Cognitive Science Conference 2013 **on** Learning and Memory: The Enlightened Mind **;** May 4, 2013**,** http://cssa.berkeley.edu/conference.php.
10**.** IBM Analytics, Streamed live on May 2014, http://www.ibm.com/big-data/us/en/big.**,** IBM Watson Cognitive Computing Deep Dive**.**
11**.** The white paper, "Computing, cognition, and the future of knowing https://ibm.biz/BdHErb.
12. 100 Best Cognitive Computing Videos**.**
13. Challenged with unstructured data? Cognitive computing can tame it, Slava Frid, Vice President, Solution Architecture**.** webs player.
14. Cognitive Computing on Hadoop, Low Tech and High Tech Approaches, Ted Dunning View Bio.
15. Cognitive systems for chefs. http://www.ibm.com/smarterplanet/us/e...
16. Jerome Pesenti, Vice President of Watson Core Technology at IBM, talks about "The Dawn of Cognitive Computing.
17. Cognitive computing on Wikipedia, September, 2014.
18. Basit chaudary, " Past Panacea: How Can Data Actually Drive Healthcare Transformation?",Center for business intelligence and Analytics; 2015.

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