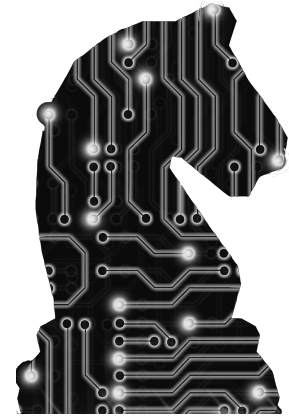


Cognitive Advantage

A Response to the New Paradigm of Hyper-Accelerated Decision-Making Enabled by Artificial Intelligence. By Richard J. Carter, Ph.D.



We are moving into a new paradigm of hyper-accelerated decision making, where artificial intelligence and machine learning facilitate automated action at a pace and scale that human minds alone cannot keep up with. Cognitive advantage provides a basis for responding to this trend; it is the demonstrable superiority gained through comprehending and acting to shape a competitive environment at such a pace that an adversary's ability to comprehend and act is compromised. In the longer term, cognitive advantage provides the means to cultivate the broader sustainability of the environment on which the organisation depends. This white paper provides context for this trend, summarises relevant scientific understanding and codifies the distinguishing features of the type of organisation that will succeed and lead in this new competitive landscape – the cognitive enterprise.

The shifting sands of competition

There are many examples of AI out-competing human intellect: beating world champion chessmasters¹ and Go players², detecting breast cancer³, through to autonomous cyber warfare^{4,5}. The quality exhibited by AI that allows it to out-compete humans is the scale and speed of its data processing capacity. This enables many alternative actions to be assessed concurrently based on an analysis of the present situation. Testing vast numbers of alternative hypotheses – primarily in synthetic digital environments – can yield successful strategies that would simply be too expensive, time-consuming or dangerous for humans experimenting in the real world to discover.

In the same way that it would be unthinkable now to run an organisation without computers – whereas 20 years ago that would still have been possible – in another decade it will be unthinkable for an organisation to function without an army of AI that enhances human capabilities.

The penetration of AI across industry and government is already significant and

contributed to a global digital economy that was valued at \$11 trillion in 2018, fuelled by the generation of 33 zettabytes of data (the equivalent of 660 billion blu-ray discs)⁶. By 2025, with the expansion of the Internet of Things enabled by adoption of 5G and cloud technologies, the digital economy is forecast to reach a value of \$23 trillion – with AI as a major driver of growth⁷ – and to be generating nearly 175 zettabytes of data annually⁸.

Within this context 'data is the new oil'⁹ holds some truth as the driver of the digital economy. Insights from data can provide an understanding of what is happening with customers, infrastructure and competitors; but it takes work to extract such value, and simple understanding is not enough. Businesses and governments also need to apply data-driven insight to inform action at sufficient pace to generate precise, high impact effects in their operating environment. AI facilitates augmented and automated decision-making to achieve the speed required.

AI is already taking us from the existing paradigm – of seeking an information advantage as the basis of competing



successfully – to one of hyper-accelerated decision-making. In a world where everyone is investing in AI to make better and quicker decisions, how is it possible to compete?

I advocate that the main driver for success in this new paradigm is the ability to shape the environment that is generating the data flowing within the digital economy. The focus therefore needs to be on building and maintaining operational capabilities that enable deep, insightful action. A cognitive advantage is the new basis for power in an AI-rich world and I define it as:

the demonstrable superiority gained through comprehending and acting to shape a competitive environment at a pace and with an ingenuity that an adversary's ability to comprehend and act is compromised

Consequently, the competitor that has an insufficient understanding of their environment will make poor decisions that are little better than random chance. As time goes by, and without drastic intervention, this will lead to further regression of their ability to act with impact.

There is a duality to holding a cognitive advantage: the power to compete and win can also be used to cultivate a sustainable operating environment for the organisation.

This latter point can be described as acting with sagacity. Sometimes this can lead to action that appears counterintuitive, for example, where an organisation is both competing against but also cooperating with another organisation (see 'Samsung vs Apple'¹⁰).

Both of these aspects of cognitive advantage will now be described.

Out-pacing and out-innovating adversaries

Cognitive advantage is about understanding the operating environment to enable rapid exploration of options, to then take precise and deliberate action to successfully shape the environment in the organisation's

favour; and to do so at pace. Cognitive advantage builds on the concept of information advantage by explicitly including elements of decision-making such as comprehension, prediction, goal setting, evaluation of alternatives and action. It is an approach that requires the effective fusion of artificial and human intellects.

Example 1. Amazon Web Services (AWS) is the market leader in the cloud service sector with a 33% share¹¹. The platform was launched in 2002 and AWS have continued to build rapidly on their first mover advantage to become the dominant solution in the cloud services market; they benefit from the 'network effects'¹² of facilitating exchanges between a growing community of customers and suppliers. Key to their success is their extraordinary rate of innovation. In 2019 AWS was releasing ~2,000 new capabilities onto their platform every day. By comparison, AWS' nearest competitors – Microsoft Azure, IBM and Google – do not publicise their rate of innovation in this way and are focused on growth through acquisition of other cloud companies. Time will tell which strategy will win out. For now, AWS continue to leverage their ability to comprehend (use of machine learning to analyse and report trends on platform usage), to act (a skilled workforce, they own the platform) and to do so at pace (they have a culture relentlessly focused on time-to-market).

Example 2. During the UK's 2016 EU referendum, the Leave campaign employed a team of data scientists to analyse the behaviours of sections of the voting population on social networks¹³. Using Facebook's analytical services, they were able to identify opportunities to influence the voting behaviour of individuals. They targeted these individuals with messaging that favoured a Leave vote, testing a variety of content. Crucially, they were able to monitor and assess the impact of this content in real-time and adjust their messaging accordingly. Their extensive use of data analytics to inform precise, high impact interventions proved to be their 'secret weapon' to counter the Remain campaign who relied on more traditional



approaches to communicating with the public, such that their ability to comprehend the impact of their efforts, and therefore adapt, was limited.

In 2017, the US Air Force's General Goldfein succinctly captured the transformation underway in defence and national security when he stated that "... we're transitioning from wars of attrition to wars of cognition..."¹⁴. Taken to its logical conclusion, cognitive advantage leads to an adversary experiencing cognitive fatigue, which renders them incapable of keeping up with, or effectively responding to, their environment. Of course, the exit of an adversary from an environment may have its own consequences; the cognitive enterprise would have already predicted the effect of such an event.

Acting sagaciously

Sagacity is variously defined as: having or showing understanding and the ability to make good judgments¹⁵; keen discernment and farsightedness¹⁶; a shrewd and judicious understanding of human motives and actions¹⁷; and acute insight and wisdom¹⁸. Acting sagaciously is about thinking and acting in the best interests of the long-term viability of the operating environment in which the organisation exists. Sagacity is not about altruism (although that may play a part); it is the holistic view of the role and the impact that an organisation has in its environment, and therefore its interdependency with its environment, and which it shapes through its own actions.

Every person, team, company or government has the possibility of bringing wisdom – sagacity – to its operation. Collectively, an organisation can make astute assessments of what is going on and form wise and humane views on what it should do next, on what would have the most beneficial impact in society. An organisation that exhibits sagacity – through the collective behaviour of its artificial and human intellects – recognises that what benefits society also benefits itself.

In the field of biology it has been observed that healthy ecosystems are neither overly efficient or excessively diverse¹⁹. They are sufficiently efficient and sufficiently diverse to allow them to persist – to sustain – over long periods of time. There is a balance between efficiency and diversity – a 'window of viability'. Too efficient, and the ability to adapt is limited; too diverse and resources are wasted. Species that endure exist within this window of viability. The long term success of any company or government relies on the ability to maintain itself in this window of viability. A short-term, parasitic approach to operation may ultimately cause the entire ecosystem to fail.

Ecosystems are constantly being disrupted because there is constant innovation, there is constant striving to outcompete and outmanoeuvre the other players in an ecosystem. This is also true for social, political and commercial ecosystems. It is critical to understand the environment, and to predict how it is likely to change. That gives the ability to plan, and beyond that, the ability to shape the environment to the advantage of the organisation and the people it serves.

Successful organisations not only respond and adapt to disruption in their environment – they create disruption to give themselves an advantage; and the pace and scale of that disruption will increase exponentially as automated decision making becomes mainstream.

Example 3. The nascent field of distributed applications, enabled by Distributed Ledger Technology²⁰, may have a profound impact on the global economy. The ability to transact peer-to-peer, without the need for a trusted third party to facilitate (such as a bank), could disrupt many business models across all industrial sectors; and as some organisations embrace the transparency proffered by such technology, for the benefit of their customers, those who do not will begin to stand out for the wrong reasons. One example of an organisation intending to increase adoption of decentralised applications is Holo with its development of the Holochain protocol²¹. This protocol, still



in development, is designed to enable distributed applications to run with thousands of times less overhead than the current leading protocol for distributed applications, Ethereum. Benefits to users include owning their own data and controlling their own identity; and promotion of democratic, co-operative platforms.

Example 4. China's sometimes surprising actions in the wider world indicate a more profound disruption. As part of their Belt and Road initiative²², China is investing billions into infrastructure projects around the world; and doing it with few apparent strings attached. They are playing a long game, and it may like a smart move. Infrastructure shapes environment. It dictates the movement of people and of goods. As a country they appear to be pursuing a cognitive advantage trajectory and are positioning themselves to shape the world in unforeseeable ways. Traversing such global expansion is generating consequences such as de-forestation and CO₂ emissions; and humanitarian causes will remain a significant challenge. The level of sagacity they bring to this endeavour remains to be seen.

Orchestrating a collective intelligence - the cognitive enterprise

The structural element of building and maintaining a cognitive advantage is the cognitive enterprise. This is a form of organisation that is centred on informed dialogue and decision-making by the right people, equipped with unique data insights and augmented by artificial intelligence.

A key motivation is to reserve human time and effort to those activities that we are best suited to: ingenuity, wisdom and compassion. Such a human-centric ethos is pre-eminent in designing the cognitive enterprise. To make the best use of human time, artificial and human intellects must be combined to form a collective intelligence. This intelligence will drive the most

efficacious collective action to maintain the organisation within a window of viability.

The critical centre of the cognitive enterprise is the *synthetic core* – an encoded representation of everything that the organisation has learned and continues to learn about itself and its environment. This body of knowledge and meaning is queried, explored and updated by the collective intelligence of the organisation. An effective synthetic core will require the integration of a diverse range of capabilities in artificial intelligence, behavioural science, cloud computing, complexity science, data science, decision science, knowledge management and simulation environments.

Individuals perceive and comprehend things differently from each other; in groups, comprehension changes and knowledge is created due to a dialectic process²³, with people informing and being informed by each other's opinions. For much of the second half of the 20th century, the majority of organisations have cultivated a 'hero culture', with everyone looking at the leader as an all-knowing mind. In the new, fast-moving world of automated systems, this will no longer work. Google, for example, takes a more distributed approach to leadership. The founders recognised that for Google to really flourish and grow, they needed to cultivate a culture where everyone was encouraged to openly innovate and to lead in their own unique way²⁴.

As we pass information and knowledge between individuals and teams, up to the more ephemeral organisational level, there is dialectic influence here as well. The integration of these information feeds gives rise to a mutual understanding of the current state of the operating environment. This is where collective intelligence arises.

That collective intelligence is greater than the sum of the parts – there is emergence, in the complexity science sense. From that collective intelligence emerges understanding, realisation and insight that no individual in that organisation could have reached alone. Organisational



understanding, or corporate understanding, comes from the collective understanding of all elements.

The cognitive enterprise encodes these insights into the architecture of the organisation, meaning the design of processes; the types of people and skills employed; the software; the hardware. The architecture of the enterprise is centred on cognitive functions that optimise the informational and operational limits of the organisation.

It involves consciously designing an organisation to maximise the collective intelligence of human and artificial workforces as a critical, protected asset. The interdependency and interflow of ideas and knowledge and information between all human and artificial entities is what gives the edge to the organisation as a whole – and the edge here is about having a cognitive advantage.

What does a cognitive enterprise look like?

Customer/Citizen. From the perspective of a customer, or citizen, a Cognitive Enterprise is in tune with what they are thinking at that time, taps into their belief system and provides the products and services they need, when they need them. This comes from having the right amount of information about them, and with that power and that deep insight into the behaviour and experience of a single individual human, comes responsibility and accountability. Trust will become increasingly important and a vital asset for any organisation.

Competitor/Adversary. From an adversary's viewpoint, the actions of a Cognitive Enterprise are an enigma. It won't be until after an organisation has shifted the environment beyond recognition that competitors will begin to understand what has happened. Competitors will act but with reduced confidence in achieving their intended effect. This may lead to competitors over-analysing to the point of procrastination and subsequently a lack of

action, or the opposite, an explosion of a full spectrum of actions that will be of questionable benefit and almost certainly unsustainable.

Partners/Allies. From the viewpoint of a partner organisation, a cognitive enterprise is loyal, trusted, has a clear vision and is good at communicating it to its partners. Also, because a cognitive enterprise organisation excels at understanding its environment, predicting and anticipating and making active moves to shape that environment, those organisations tend to know more about their partners, and how they are performing in that environment than the partners even know themselves. They can hold up a mirror and point out to trusted partners where they have blind spots, such as a competitor they are not paying enough attention to. The cognitive enterprise looks after its partners because it is dependent on them; it understands its dependencies in the ecosystem and invests in managing them, which has enormous value to the partner.

Workforce. People who work within a cognitive enterprise love it: in the same way the organisation excels at giving customers what they want before they even know they need it, it applies that same power of insight to giving the best to its people. The way to get the best from people is to make them feel valued, trusted and understood.

The challenges of building and maintaining a cognitive advantage

The challenge to building a cognitive advantage can be summarised as getting the right data, to the right intellect, at the right time, to have the right impact, guided by the right values.

Data, data everywhere but not a byte to eat

Every organisation has an informational limit²⁵ which is the amount of data that it can gather and process to inform action. There is a finite limit to the physical resources



(people, money) and the technical resources (data analysis capabilities, knowledge) available and so the challenge is in optimising the data aperture of the organisation. This is an iterative process, requiring capabilities in data analysis, in understanding how, why and where data is generated, and interpreting the value of the data in terms of impact. Some investment is required to start the process, with initial trial and error followed by continuous learning to inform and refine what data is needed.

The needs of customers/citizens are changing on a daily, even hourly, basis. Real-time, continuous feedback of large amounts of data from which to identify patterns and emerging trends to comprehend what is happening and what may happen next is the hallmark of a digitally capable organisation. One only needs to look at the empty supermarket shelves that appeared in March 2020, as the Covid-19 lockdown began, to see the consequences of failing to spot these patterns, or to maintain sufficient adaptability to respond to potential change.

The classic example of mishandling informational limits is Kodak²⁶. They were defining their informational limits to the existing industry for photography, investing all their resources based on certain assumptions about the future direction of their industry. At the organisational level they didn't understand the emergence of digital technologies – even those they invented themselves, including the digital camera – so they were completely blindsided.

There are three main approaches to gathering data: directly, with some sort of platform or device in the environment that is capturing information; buying data, whether that's ad tech, or a commercial data analysis company that scrapes the internet on a daily basis and does its own analysis; or the vast repository of open source data available on the internet. Whatever it is, a data strategy will be required that clearly outlines how the digital economy will be used – for example, the investment in proprietary data vs. acquired data - to achieve the purpose of the organisation.

Using our 50 bits per second wisely

It is estimated that when we are reading a book or solving a puzzle our conscious mind processes a maximum of just 50 bits a second²⁷. This is a very slow, very expensive (albeit powerful) cognitive load, so it is important to optimise the use of this precious resource. For reference, the Nvidia GTX 960, a cheap consumer graphics card from 2015, has a throughput of about 50 gigabits per second; a billion times more.

The functions of cognition – sensory input, encoding, processing, meaning – can be viewed as a hierarchy: data at the bottom, then information, knowledge and finally wisdom at the top; the scarcest and most valuable. At the moment, many humans are using their 50 bps down at the data level. In an AI world, that no longer needs to be the case. Ideally the genius of our über-expensive but talented, compassionate and moralistic humans should be focused on wisdom, where humans can add the most value, and let AI do as much as possible of the rest.

The huge amount of information and knowledge needs to be encoded in a form that is accessible to both artificial and human intellect alike. Data-linked models deployed on a cloud infrastructure provide the flexibility and the scalability required.

This semantic graph is an encoding of the collective understanding that the collective intelligence has on the environment. Cognitive functions such as reasoning, learning, knowledge retrieval provide access into this knowledge store. As a whole, this knowledge store – and the means to query, explore and update it – are called the *synthetic core*.

To fully utilise the sophistication and complexity of the synthetic core it needs to be accessible. As such, the human-machine interface will take on an even greater priority if we are to extract the maximum value from the collective intelligence of our artificial and human intellects. This is where we can learn from the videogames industry; they are, after all, experts in creating large-



scale virtual worlds that equip humans – often with AI working alongside them – with the ability to act and to problem solve to win in a rapidly changing simulated world, competing against other artificial and human players.

Embracing technology developments such as augmented and virtual reality, haptics, data visualisation, simulations and natural language processing will enable humans to fully utilise the synthetic core.

Mastering deep insight

A key difference between the general intelligence that humans possess, and the narrower intelligence of AI, is the ability to take learning from one context and apply it to another. For example, if a deep learning algorithm is taught to recognise dogs, it can't simply transfer that knowledge to immediately begin recognising cats; but humans can transfer knowledge about dogs to cats somewhat successfully.

This is because humans can conceptualise. We can infer relationships between concepts either through experience or through inference. From this ontological model we can anticipate how our environment might change. This requires us to seek to understand cause-and-effect in our world – no matter how rudimentary – and we do this by testing hypotheses. We imagine and creatively link concepts that we have yet to experience. We then seek data to assess the credibility of such connections.

This ability to think laterally, to make new connections through a creative union of causal concepts, can unlock new, previously hidden knowledge about our environment. From this deep insight we can synthesise precise, deliberate action to inject influence into cause-and-effect pathways.

Data science alone will not achieve this. We will need to fuse it with other disciplines such as causal analysis and complexity science.

Causal analysis²⁸ goes upstream of the data itself and seeks to understand the system

that has generated the data; to seek out the answers to why and how the data was generated in the first place. However, many real-world processes are non-linear – predicting an outcome from the occurrence of an event is generally poor due to small variations in the conditions that caused the event leading to large changes in the effect. This makes inferring causality hard.

To resolve this, we need the multi-disciplinary approach of complexity science²⁹ which brings with it the tools of information theory, statistics, dynamical system modelling, agent-based modelling, and large-scale computer simulations. This will allow us to explore, experiment and problem solve across a wide range of scenarios in a synthetic environment so that, in an uncertain world, we can begin to anticipate likely outcomes.

To do this at a scale and a speed required to pursue a cognitive advantage trajectory, AI will be required to automate such reasoning and to automatically update the synthetic core – the knowledge store – of the cognitive enterprise. There is a more profound aspect to causality and AI too, as Judea Pearl stated, ‘... AI can't be truly intelligent until it has a rich understanding of cause and effect ...’³⁰. Investing in causal analysis of an organisation's body of knowledge may also enhance that organisation's proprietary AI capabilities too. Which, in turn, will improve the cognitive capabilities of the organisation as a whole.

Developing sagacious leaders

In the latter half of the 20th century, the ability to win at all costs has been the main compass by which we have lauded and rewarded leaders. Maximising shareholder value or winning votes has been the largely unquestioned aim and a board that is responsible to its shareholders or to party members need the best person for that job. Action happens, but is it wise action? Ethical work practices, caring about people from a more human perspective, have become secondary, or fallen away altogether. Using an algorithm to judge a human workforce –



such as Amazon's infamous 'the rate' algorithm³¹, which has led to mental health issues in the workforce – is a stark reminder that AI can introduce new, unintended consequences.

As AI becomes increasingly used to augment and significantly increase the cognitive capabilities of decision-makers, it becomes supremely important that our leaders of tomorrow have a strong foundation of ethics and morality. The Greeks and the Romans placed emphasis on the qualities of a good leader. In *Meditations*, the Roman Emperor Marcus Aurelius said, "Don't think about being a good person, just be that good person"³² whilst citing attributes such as wisdom, temperance, charity and compassion. We need to set greater expectations for our leaders along these lines.

A sagacious leader is someone who embodies such values whilst also having the innate ability to process complex information³³ – ambiguous, volatile, incomplete – to inform action that has profound impact. Oftentimes such decisions may be tactical, short-term and immediate. But the sagacious leader is also comfortable with the abstract. Sagacious leaders are comfortable with developing strategy shaped by ethos³⁴.

With the right mix of minds, better decisions can be made; a more well-rounded leadership team gives a deeper, more insightful, more morally balanced view of the major strategic decisions that their organisation needs to make. Difference of opinion is critical to arrive at the most sagacious actions³⁵.

"If we were starting from a blank canvas and we knew about the AI capability that is coming, how would we organise ourselves to best take advantage of this? How would we organise ourselves to make the most of what's now possible, so that we can launch ourselves onto a cognitive advantage trajectory? And how can we do all that in such a way that we shape the environment we operate in so that it thrives?"

Conclusion

To build and maintain a cognitive advantage requires:

- Sensing, thinking and moving faster than your adversaries and maximising the use of AI to do this
- Being sufficiently self-aware of the fit of the organisation to the operating environment; continually adapting to optimise the collective intelligence of the organisation
- Relentlessly shaping the operating environment to maintain a cognitive advantage

Whenever there is a paradigm shift in technology – the integrated circuit, the internet, mobile communication technology – there are those organisations that fail to adapt. The new paradigm of hyper-accelerated decision-making enabled by AI is no different.

However, this is not about responding and adapting to changes in the operating environment that this brings. Ultimately, this is about shaping the operating environment, enabled through having a cognitive advantage. This introduces a shift in how we think about the ideal organisation. Whilst agile organisations are currently seen as the exemplar for being competitive, in an AI rich 'cognitive' world, being responsive to change is not enough. Agile organisations respond, sagacious organisations shape.

To become a sagacious organisation requires foresight and a willingness to act, even when there is no immediate threat to the organisation. It is about asking:



About the Book

The book 'Cognitive Advantage – How Artificial Intelligence and Complexity Science are Changing the Rules for Winning in Business and Government' by Richard J. Carter is available for Pre-Order on Amazon.

About the Author

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