The business value of AI: An executive leadership perspective

By Peter Keen and Ronald Williams

Here's yet another article on AI to add to the many targeted to business executives. Some are prophetic and focus on how it will change society, business, work – well, Everything. There's a subfield stream on robots replacing people and their paychecks; the Machine is smarter and cheaper than your workers. Many publications are evangelism: Join the Machine Learning Revolution NOW!

Most are tutorial: Here's what AI is, with the shorter explanations often cursory and selective in coverage and the fuller ones gnomic and packed with polysyllables and acronyms. There are plenty of views and striking examples plus wildly varied accompanying opinions. Stir all these up and AI too easily loses clarity, focus and, most of all, a business management perspective.

So why read this addition to the AI word count*? Because there's no way any manager can reliably know just where AI is going and we will only find out when we've got there*. Robo-guessing, Evangelism and Tech 101 don't change that. They all draw attention to AI as a phenomenon and artefact and downplay the business context in which it becomes a vehicle for creating value and shaping growth.

This is reminiscent of when e-commerce was seen as all about Web sites and the value as hits and clicks. And, of course, mobile phones were once for making phone calls, with SMS text the "killer app." Take a glance at the multiplicity of apps that are now on your phone: how many of them were predicted, predictable or even imaginable the year before, say, the iPhone?

The management challenge for AI is to plan when you can't predict, not predict so you can plan, This is again reminiscent of the e-commerce gambling casino. Our briefing paper offers a perspective that centers on what we can reliably learn from the general direction of AI impacts on business change, rather than just speculate about. Only then can executives assess what AI points to for their firm's development in its current and potential competitive ecosystem, leveraging its organization, technology and financial capabilities.

The core issue: is AI Transformational?

Our focus is on the three questions that frame the choice of AI strategy and, perhaps, change in basics of the firm's business model. The answers help set up systematic planning.

- Does AI change business basics or largely add to existing best practice and process?
- How quickly, why and by how much is it already reshaping the competitive landscape?
- How well-resourced are we organizationally and financially to respond*?*

These can be clustered as one overarching concern:

Do we, the leaders of the enterprise, see AI as transformational, requiring that we ensure a radical response?

This really is the management issue. If AI, from the perspective of business leadership, is on track to be as foundational in industry disruption and creation as e-commerce, as pervasive as social media and as universal as mobile apps, then it obviously demands an aggressive statement not of AI "strategy" or "business plan" but of what is best termed Ambition. This is a clear signal that the

firm is looking to break away from business norms, make long-term commitments now and accept a higher-risk exposure. That signal must flow across, up and down the organization and provide for a shared understanding not so much of AI but of its dimensions of opportunity to create new streams of value.

Conversely, given all the uncertainties, hype and hope, lack of clarity and range of practical applications of AI, if it is not to be handled as open-ended Transformation, there is even more of a need for such a signal that more narrowly focuses Ambition and sets a very clear direction, including what paths not to jog along. The alternative is a strategic drift that is creating widespread leadership ambiguity and inconsistency in many organizations. Contradiction clouds Ambition.

The AI leadership contradiction

Many leaders seem to accept that there is something consequential moving across the AI landscape but act as if breaking away on a radical new path is not a realistic or needed goal. Surveys show that around 70% of executives do regard AI as transformational, but also that only a fraction of firms are implementing it as more than just an evolutionary and piecemeal collection of initiatives. They think transformational and act incremental.

The figures are consistent over the past 3-5 years: a late 2018 McKinsey survey shows that only 21% of respondents had implemented AI in multiple business functions or unites. Most firms have not mapped out where best to apply AI. The same one in five applies to executives: this is the reported fraction who are comfortable that they know what AI actually is. The percentages have not varied much by year or across surveys. High intentions: 70%. Real progress: 20%.

This has resulted in a bits and pieces approach to AI: off the shelf machine learning toolsets, chatbots, more ambitious warehouse robots, data analytics, image processing, virtual assistants, robotic process automation, and many others. They focus initiatives on well-defined tasks with needed data already available. But by and large there's no overall organizing and crystallized articulation of Ambition: where the firm will treat AI uncertainty as an opportunity to generate new dimensions of value or lower the risks of that uncertainty by relying on proven tools and others' experience.

It's not that either extreme of Ambition is "best" but that the choice should be clearly made, crisply articulated and consistent as a framework for turning Ambition into action. For instance, one far-ranging factor in targeting AI to Transformation is that the more innovative the machine learning models, the more extensive the demands for new sources of data to learn from. Much of this rests on new collaborations and complex comprehensive technology investments. Those is turn demand new sources of talent and expertise.

In medicine, the Electronic Health Record, conceived as an extensive tool for patient care, evolved mainly for administration and record-keeping. It is now being integrated into AI diagnostic hardware and software. If the Ambition is Transformation, then it's an essential resource. If it's narrowed down to augmenting and enhancing, say, diagnostic processes, it's not relevant to the innovation. Does that matter today? A year from now? Who takes the lead? Makes the decisions? Where does this fit in the activity plan for AI?

This is not a matter of meeting the old cliché of getting everyone on the same page: make sure they are reading the same book. If you walk around just about any business, hospital or public agency and ask people what AI is and what they see happening in the organization, you will get a blur of the Smart Machine/Evangelism/Tutorial views – or just an "Er?" At the very same time, the firm's business and IT leaders are taking a public view that they see AI as core to its innovation.

The source for our assessments is the mass of surveys and opinion pieces on AI. Of course, it's perhaps stereotyping and overselective and more our opinion than consensual fact. But it is at the least an alert. Check out your own organization. Same page? Same book? Clear Ambition?

Focusing for action: three levels of AI Ambition

There are three action-focused profiles of response to the Ambition-setting questions: Break Away, Morph and Augment.

These are not abstract conceptual models but the clusters of approach to AI change management that emerge from the myriads of detailed published descriptions of applications. They capture the clear patterns apparent in the here and now of implementation and the explicit management perspectives that are driving it.

1. Break Away: The most Ambitious response to AI is that it demands a Break Away ambition; it is almost axiomatic here that AI is indeed Transformational, with a momentum that carries industries, customers and society along new paths. This has to be met with a commitment to doing much more than following the pack and extending business as usual. We may not have scenarios for an AI-pervasive future, but we can be sure it will be radical and volatile.
   Break Away is the territory of headlines and billions of dollars for self-driving cars, large workerless warehouses, Facebook and Amazon's monetizing of keystrokes, and hospitals that are a giant Faraday cage of electromagnetic fields feeding a new generation of diagnostic and treatment tools. These are the radical responses. They are affordable for just a fraction of firms.
   But it's also the agenda for SMEs and established industry core players. e-Commerce suggests that they will be most at risk if AI is Transformational in their wider context of customer,

competitor and collaborator spheres. So, do they play defense or find their own Breakaways? How do they niche? Where do they cooperate in order to compete? What's the basis for prioritizing? Break Away players look to be pace-setters, not in AI but in creating value from AI's opening opportunities.

2. Morph: Here, the assumption is that AI will be a Morphing rather than a revolution and marked by continuous change that accumulates to reshape the business. Morphing aims to keep pushing the limits of business as usual to create business as different. The established foundational structure ends up with a new character and appearance. The analogy here is that the beautiful butterfly looks entirely different from the caterpillar from which it grew. Morphing is very much a shedding of old business skin and stretching wings,
   That shedding and stretching may sound simple but it demands a long-term set of technology infrastructures, process and service platforms, data management complexes, and combination of in-house skills and collaborative relationships. It rests not just on single projects and applications but on making sure they are integrated and build up to be more than the sum of their software.
3. Augment: Adopting AI to augment business activities views it as a continuance of developments in technology that add new opportunities to enhance, extend and renovate processes, operations and relationships. The logic of Augment is to go after the "low-hanging fruit", proven opportunities of chatbots, image recognition, voice interaction, robot vision and Deep Learning, simply because there are so many trees laden down and ready for the picking.
   This is very much an ROI approach. It empathizes quantitative metrics and limited risk exposure. It also is often flavored by the belief that for most firms, there is little if any sustainable competitive differentiation for being on the famous bleeding not leading edge of innovation. The wonder apps of 2009, or even later, are ho hum technology commodities of 2019: Siri and Alexa are obvious instances. The value of AI will come from smart implementation and process management.

There are strong cases to be made for and against each of the three levels of Ambition. Our aim is to help managers reach their own decision, based on where, how and with what impacts AI is creating something really different that stands out as resonant in possibilities, not just neat or interesting. If AI is indeed transforming business what are the actual changes and how do these translate to previously unavailable or unachievable dimensions of value?

Here's our assessment, derived from a sense-making analysis of a kaleidoscopic mix of real world applications that are well beyond the pilot stage. In our research, we increasingly found that much of the standard terminology in AI discussions didn't capture key aspects of theory and practice. In particular, the commonsense and abstruse conceptions of "Intelligence" were both unhelpful in clarifying the components of human and machine capabilities and constraints. The word has become little more than a loaded term that explains surprisingly little.

What emerged from the most useful body of theory in both AI and human cognition and in the examples of AI strategies and results was that the binding link is the concept of Patterns as fundamental to cognitive performance. The transformative potential of AI comes from its breaking some limit on Pattern-building and application.

We have found our Pattern Power-Limit Breaking framework comprehensive, pragmatic, insight-generating and general and offer it as a perspective that may be of direct value to our management audience. It highlights as the main general forces to focus on:

- **Pattern Power** as the distinguishing value to be created through AI.
- **Limit-breaking** as the enabler of new value opportunity.

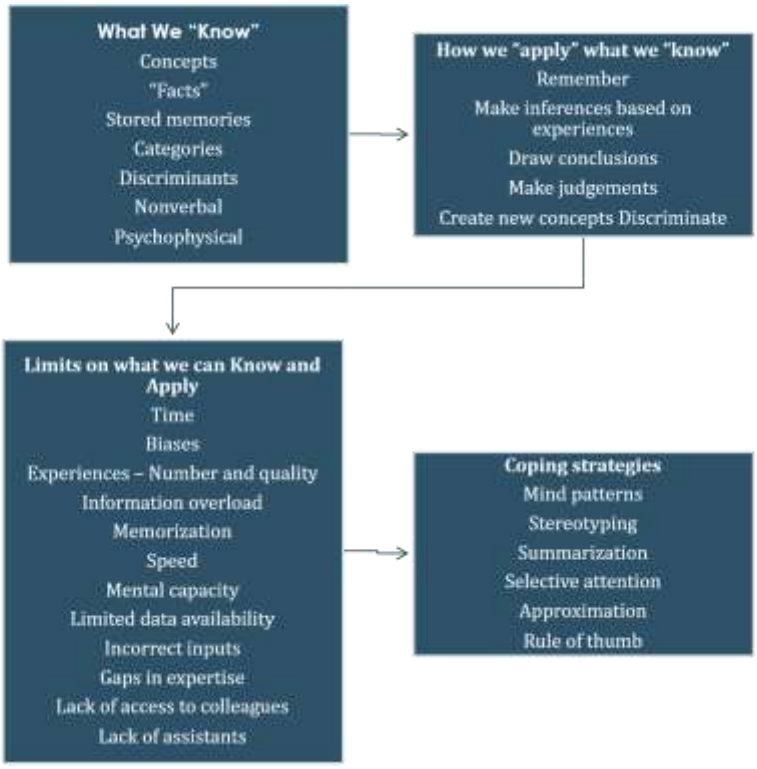
Patterns: the core of Intelligence put to effective use

Patterns, whether human or machine-generated, are the mental templates by which we make sense of situations and bring to bear what we "know" as efficiently as we can. Our minds work adaptively in patterns because this has evolved as the most effective way to literally use our brain, with all its strengths and limitations. We can't remember every detail, explore all the possible combinations of options in decision making, keep track of changes or handle detailed calculations. We invariably have gaps in our knowledge and most of all just don't have time to spare.

So, we economize through Pattern-building. Patterns are the purpose and endpoint of human learning. They are all the positives associated with "Intelligence" put to effective use: knowledge, learning, insight, analysis, understanding, experience, practice, accuracy, objectivity, awareness and the like. Intelligence translates from capacity to impact through Pattern Power.

We shape Patterns by categorizing details, organizing concepts, cutting out irrelevancies, sometimes stereotyping or skipping over inconvenient contradictions. We also put most effort into learning and applying our best thinking to the situations, routines and decisions of everyday importance to us – a professional writer worries about the Oxford comma, proper use of colons and placement of adverbs and builds patterns of good "style." The typical email writer has no reason even to ask what that means.

Our pattern-generating capabilities have many limits, summarized in the following diagram.

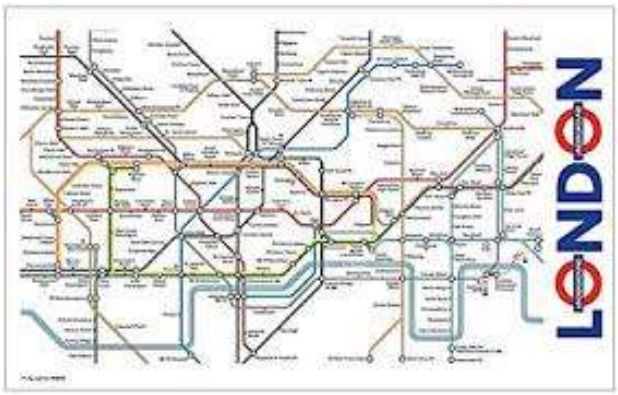


Human Pattern Power

The value of AI comes from breaking these limits: what we "know", what we can apply and how we cope.

Patterns are closely linked to maps. They are the representations that offer us practical tools for coping. We often treat them as exact models of reality. They are not that at all. To take an extreme,

if you ever try to navigate across London using its iconic map of the Underground train service you will be lost, frenetic, completely frustrated and traffic-jammed to the point of abandoning your car.



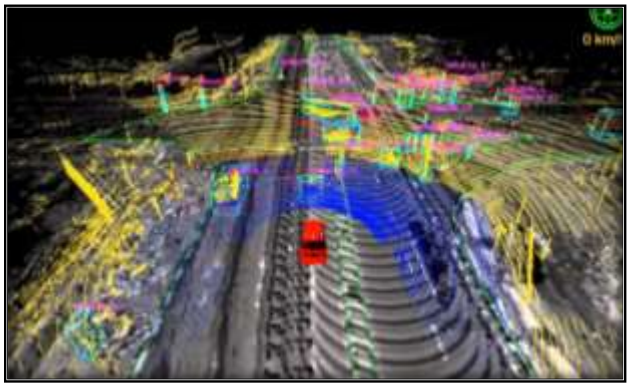
It does not correspond at all to reality on the ground. What looks on the map as a short distance may be the very opposite. A station to the North on the map may be geographically due West. And so on.

It's a terrible map for driving but a marvelous one for getting from just about any point in one of the world's largest and most complex urban sprawls to any other one via "the Tube."

Google Maps and Street View are much more accurate in their physical realism and offer a wealth of images and animation, but they are not necessarily useful patterns for driving. There's too much detail to manipulate on the fly and the richness of the display can be distracting. So, while Maps shows you the Underground station that you are starting from, it's overcomplicated for you to trace the route to another one. You need some extension, such as the many smartphone apps that augment Google Maps and GPS data.

These abstract and simplify – green for light traffic, red for slow, instructions as to when to turn, icons showing breakdowns and road repairs, etc. Options may include adding markers for rest areas, food and gas, etc. The maps even remove your need to have a pattern in your own mind. It is fully practical now to drive across the entire country without at any point having to know where you are. The patterns are on the apps, if and when you need them.

Here's a map that Waymo (Google's subsidiary) uses in its driverless cars. It's much more detailed than anything in a human head or captured by a video camera. It uses LIDAR (Light Detection and Ranging) to provide a precise mapping of barriers and terrain. It's a more accurate map than that one on your mobile phone. But it's actually useless to you for commuting. It adds Intelligence but not Pattern Power – better thinking for effective action.



The Pattern perspective focuses on how humans organize their multidimensional capabilities and habits to best encapsulate existing knowledge, new information, past and ongoing experience, memory and associations. How do they categorize an overload of signals to make sense of it all and be able to use it in analysis and prediction? How do they compensate for their shortcomings – speed, memory, time, mathematical calculations – and build on their ability to develop patterns?

The same questions apply to AI. Pattern Power is the end product of machines adding some new capability to or beyond HI – Human Intelligence. All cognition is made into useful and usable tools as patterns: representations, mental models, conceptual maps, trends, relationship, and rules of thumb.

Just one example of the areas where AI is transforming Intelligence through Pattern Power captured as new maps is supply chain integration. There is no such thing. Supply "chain" is a Pattern conception and integration is the use of that Power to frame, oversee and coordinate processes. It's an abstraction that takes all the myriads of operations involved and "conceptualizes" them, to

translate from the physical to a map. The label "chain" in effect encapsulates and orients how all this should be viewed.

It's a simplification that omits myriads of details in the interest of understanding for action. There's nothing chain-like at 3 pm today, with inventory being moved around, vehicles picking up and delivering, purchases tested for quality conformance, conveyor lines packaging and bar coding, a query on a major customer order, shortage of spare parts in one maintenance center….

Is "Port unloading" really just a neat box on a chart, "chained" to "Processing facilities" and "Distribution Center"? Where do returns of goods fit? Partial versus full pallet road versus rail transport? They are individual patterns excluded from the supply chain map.

Amazon and Alibaba are representative of today's leaders and tomorrow's mainstream in using more and more AI to include them all, dig deeper into the data they generate, and predict and optimize everything in the chain. They don't need the old mappings; to a large degree those were based on the physical nodes and flows. Now, Amazon, Alibaba and other leaders are treating these as variables within a digital information flow.

The digitalization of supply chain thinking and resulting patterns goes beyond "integration." It is generating a reconceptualization that creates entirely original Pattern Power. To take just one instance: ground transportation via road and rail is handled not as a link in a chain but a set of dynamic action triggers for routing, and even choice of highway lanes for given tonnage and weather conditions. The Intelligence coordinates sensors and scanners, signals to and from the driver's cab and order and scheduling systems. At some point, the autonomous truck will be directed by sensor data.

The main benefit of AI is how it enables Patterns that are today limited by some aspect of human and computer capabilities. A simple comparison is with ATMs. In the 1960s, they were a fantasy, since there were no comprehensive data communications services and the few leased lines were prohibitively expensive. Remove the limits and the opportunity space is opened up. AI/Machine learning is a direct equivalent. Fundamentally, AI is about Limits and the value it enables is about Patterns.

Here's a simple, short and very typical instance of how Pattern Power is created by the machine learning toolkit that is now the core of AI practice. Loan application processing has long relied on rule-based systems that use a wealth of demographic, historical and financial data. The patterns they automate are classifications derived from rules that are specified in the form of "If income is below X% of the loan amount, then… Else…" The data is preselected and categorized: property records, employment history, debt, on time payments, etc. Much of it is provided by credit rating services and may be extended to include police data bases, court records, car and house title archives, etc.

Neural models basically learn like a child does: use trial and experience learning from experience. For machine learning techniques, that experience comes in the form of data and simulated situations, that is all heavily dependent on the accuracy, absence of bias and volume of instances for "training" the AI models. Given good data, they can evolve their own patterns that increasingly add some new dimension to existing ones and outperform them. In many instances, this demands millions of trials – a century of human child learning. They can explore the data more broadly – a "waste" of time for a busy human at work. The nature of the models, in terms of theoretical foundations, methods, math and machinery, is expanding rapidly. (There are now many new types of machine learning theory and methods, but the core remains learning by trial-and-error.)

One model developed by a fintech firm (the term for companies that handle financial services digitally) evolved an entirely original pattern for assessing loan applications online, one that more

successfully evaluates risk than the mainstream systems whose patterns are based on statistics and programmed decision rules. It needs just five variables: the type of computer and device the person is using in making the application (Mac, Windows, phone, tablet), the time of day, the email address (Gmail is more creditworthy than Hotmail) and whether the person's name is part of their email address (a positive.)

It's easy to summarize the Pattern Power created here: Better decisions faster and with a great reduction in data collection and processing. Add to this: quicker response to customers; reduction in software specification of rules and procedures; continuous improvement and refinement in prediction through machine learning and learning and learning. This all amounts to a massive reconceptualization of a core business area.

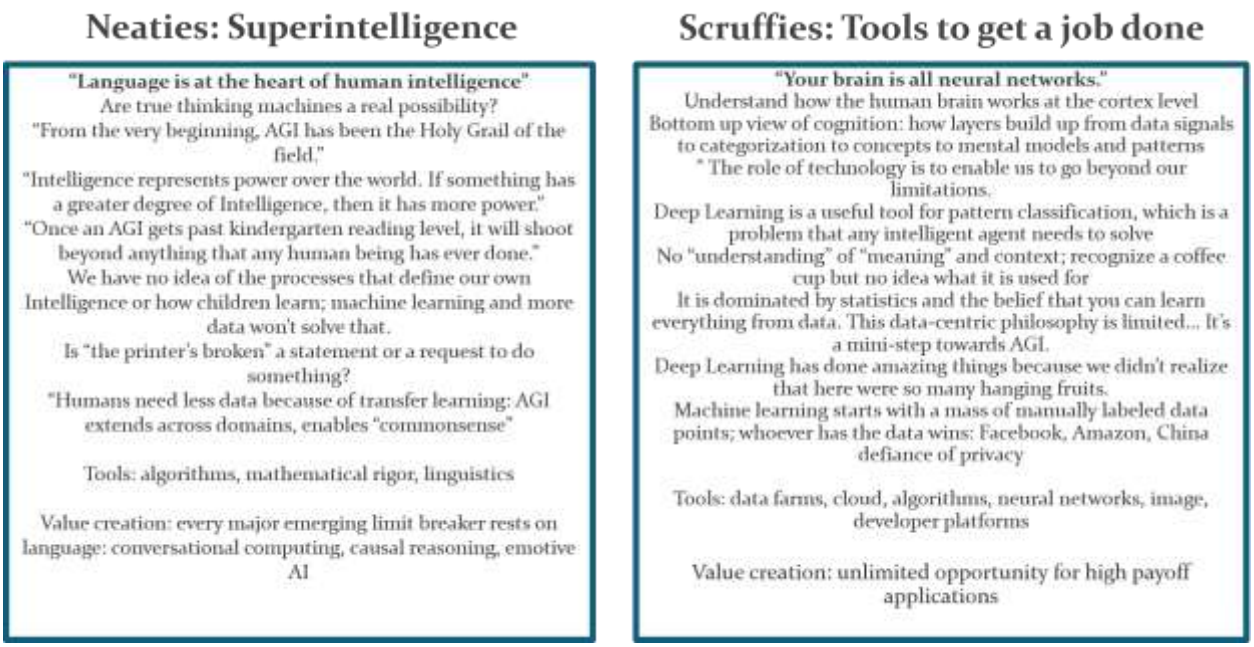
The example is small and not really noteworthy from an AI perspective – JANNM: just another neural network model. Many leading vendors sell DYI software toolkits that a reasonably skilled computer science major can put to fast use. The data is literally at the fingertips. It's a neat Augment application.

What, though, if it is made part of a comprehensive Break Away initiative aimed at transforming a financial service company's entire risk management? Restated, where could it be made such an Ambition? Perhaps the best way of summarizing AI Pattern Power is: "We would not have been able to do this otherwise. Now we can take an entirely new approach."

Neaties and Scruffies: the nature and the limits of the "I" in AI

New Pattern Power – the Ambition opportunity – comes from AI breaking some limit on either human intelligence or computing power and application – the "I" in AI. This is a vast topic, covering just about any intellectual, technical or social science field. The logic is simple. Limits extend Intelligence. The business of AI is to break limits. The role of business innovation is to exploit the new spaces that opens up.

There are two very distinct lines of development in Intelligence research, development and application. The term Neaties and Scruffies was coined by one of the leaders in AI and has been commonly used for many decades to capture how Intelligence is embedded in the technology of the Artificial and put to use, and how to apply it to more and more contexts, so it escapes today's limits. Here's a summary of the main difference



Very roughly, the Neaties aim at evolving an Artificial *General* Intelligence (AGI) – raw smarts. This is AI as Superintelligence. They focus on language and how we as humans understand what we "know." This points to the many limitations of current AI tools, especially in transferring knowledge from one "domain" to other – from learning how to pick up metallic spare parts for a machine but being totally flummoxed by a soft package of liquid. Image recognition is very much caught in the middle here. It has seen immense advances in performance – Scruffies to the fore – along with many gaps of bias, error and misinterpretation –Neaties, come quickly.

Today's AI tools are (currently at least) very weak in causal reasoning. They are hopeless at handling a question like "Do roosters cause the sun to rise?" Statistically, the answer is Yes but causally No way. Even the best natural language processing and voice recognition AI can't recognize when "my printer is broken" is a request for help versus a statement of fact. They are learning to recognize customer moods like irritation, and Scruffies take the view that they will find practical if not purist solutions to pushing through the limits of machine understanding.

Scruffies are tool builders. They made Machine Learning practical and cost-effective by their developments, to the degree that ML and AI are equivalent in most firms. But it's the Neaties that look likelier to generate the next application limit breakers. That translates to their extending the limits of AI possibilities so that the armies of very skilled tool builders, especially in the two nations that dominate AI deployment, the US and China, will fill the new space with even more and better ones.

Here are a few selected resources that provide useful orientation to the AI development agenda.

Selected book references

Intelligence
1. *Frames of Mind: The Theory of Multiple Intelligences by Howard Gardner*
2. *On Intelligence by Jeff Hawkins and Sandra Blakeslee*

3. The Tree of Knowledge: The Biological Roots of Human Understanding by Humberto Maturana and Francisco Varela
Transformation
1. Architects of Intelligence: The Truth About AI From the People Building It by Martin Ford
2. Autonomy: The Quest to Build the Driverless Car by Lawrence Burns and Christopher Shulgan
3. AI Superpowers: China, Silicon Valley, and the New World Order by Kai-Fu Lee
Tools
1. Artificial Intelligence: A Modern Approach by Stewart Russell and Peter Norvig
2. Deep Learning by Ian Goodfellow et al

A kaleidoscopic mix of examples

Pattern Power and Limit-breaking seem to be a useful and simple framework for teasing out the commonalties among both AI successes and failures. Here are just a few examples, with comments on what they signal about the likely or just potential impact on structural change for business. They are intentionally fragmented and varied. The aim is to provide an impressionistic and shifting kaleidoscopic, rather than a focused, static and systematic microscopic view.

1. Watson and Jeopardy

The general public awareness of today's AI most likely traces back to Watson's win on the quiz show Jeopardy in 2011. Ken Jennings and Brad Rutter had raked up combined winnings of over $5 million. But they were no match for Watson's speed and capacity to process the question and find the most probable answer. The questions and answers are there in Wikipedia, but being able to recall all of Wikipedia is beyond human ability. It's well within Watson's.

The IBM multibillion dollar Watson architecture and tools are intendedly Transformational. It is a massive search engine that differs from rule-based data management tools in that it breaks their limit on interpreting natural language. It has met with many successes, and also failures to build a revenue base, weak understanding of the demands of some applications, and errors in results.

But it is a robust and comprehensive platform for as yet untried limit-smashing nd pattern creation. It can, for instance, simply and continuously scan all available public journals, data bases and surveys to locate and synthesize -- form patterns – new research findings in medicine. It is able to scan the entire social media daily traffic to answer a question like "What products are most popular sales items on Black Friday?"

Google's related Books handles an estimated two *trillion* searches a year across 25 million multi-language books, mainly housed in leading university libraries, providing "snippets" and summaries.

Both of these break the limits on data retrieval scale, scope and media. Their exploitation comes back to Ambition. Google Books is a plug and play app that can be incorporated into just about any Web site, social media or customer service tool. There is no data gathering or structuring required; Google has handled that, though with many problems of copyright, scanning and cataloguing errors.

Watson is an architecture rather than an app. The treasure trove is the data it can access and the predictions it can make. In medicine this involves a massive range of sources, collaborations, categorizations and data management processes, including privacy and security.

2. Medical imaging

Medical diagnosis and treatment of ailments affecting the physiology and organs of the body have long relied on technology across modern medicine, with CAT scans, ultrasound, tomography and MRI all now major tools. These have been used through a combination of machine imaging and reporting and human radiologist expert analysis and interpretation. This is a Pattern skill. Radiologists working from the same data build their own mental models and procedures for interpretation, spotting anomalies and assessing the implications of details.

Now AI models routinely outperform the average practitioner and match the experts. They do so through machine learning that uses millions of examples to train and fine-tune the assessment. Many extend the detail of the images to sub-pixel resolution, 3D and isolation of features. One of the well-known limits of human image processing is that our patterns generally are based on a sensitivity to the fuller elements like the face, CAT scan or picture from which they then select details for closer inspection. This helps orient them but can also lead to some degree of prejudgment. ML treats all pixels as equals.

On the innovation side, enabled by the combination of ever improving radiology hardware and multi-millions of historical images to learn from, the AI capability evolves what may be taken as creative insights, discoveries and deductions. In reality, those words are the human intelligence appreciation of what ML can do that we can't. This AI doesn't "know" anything outside its patterns. Switch it from body images to metal structures and it requires a full retraining – with millions of trials and perhaps billions of bytes of data.

That said, the same ML imaging capabilities are breaking other limits in medical diagnosis, signaling not so much a Transformation as an expanding Morphing – at some stage will the butterflies leave the caterpillars so far behind that they die off? One application that merits the label of Breakaway is stroke diagnosis and crisis response. The Chairman of neurology at the University of Tennessee's Erlanger Medical Center in Chattanooga, a top stroke-treatment center sees AI as a practical and urgent Transformational force: "There is no more time-sensitive treatment in all of medicine than treating the stroke victim"

The Center is working with Viz.ai, one of the hundreds of startup specialist firms – in this instance, staffed by doctors and software engineers – that are racing onto the AI medical innovation paths. It is deriving new Pattern Power by using a subset of ML methods termed Deep Learning to analyze brain scan images, allowing a precise diagnosis of stroke victims in 6 versus the normal 66 minutes, saving lives and enabling less experienced physicians to make the diagnosis.

The main barriers to adoption of these new capabilities is cultural. They are limit-breaking in diagnosis and limit-locked in the subtle patient and patient-physician dynamics so central to effective treatment. HI outperforms AI in these patterns and physicians trust their own learning experience here.

3. Shop with no Checkout

For years retailers have piloted and implemented various forms of self checkout. Why? For starters, it is estimated that Americans spend 37 billion hours per year waiting in line, which equates to roughly 115 hours for every man, woman and child. Research has shown that people overestimate the amount of time by 36%, an indicator of its being a nuisance. It is no surprise that according to a Harris Poll 88% of U.S. adults want the checkout process to be faster and 30% feel like a burden to the clerk and other customers when they have a full cart.

But for all the effort the problem has not been solved to either the customer's or merchant's satisfaction. Rule-based systems that just transfer the work from the cashier to the customer have not worked to the customer's satisfaction.

Amazon is trying something new. With Amazon Go, a customer enters the store and scans in with a smartphone. Shoppers walk through the store picking items off the shelf, adding them to their basket or putting them back if they change their mind.

When they are finished, they simply walk out of the door and their purchases are added to their Prime account credit card. No bar codes, no RFID – just computer vision, sensors and ML pattern power. It has been estimated that Amazon Go stores sell 50% more than comparable convenience stores. Now Tesco in the U.K. and French retailer Carrefour are piloting similar systems.

Amazon Go is packed with AI, most of it invisible and very much protected as trade secrets, linking back along the supply chain/web/ecocomplex, just as your smartphone is the access and delivery point for customized services and data. One patent application deals with items that are difficult to identify, such as a bottle of ketchup versus tomato sauce. The AI checks the customer's purchase history to see what it is most likely to be.

Others deal with occlusion – the image recognition tracking view is blocked by someone or something in the store – and "tangled state" – too many people crowding together. Then there's pose estimation via "a cross entropy loss function… self-regression for vector generation and pairwise regression" that is very useful in working out when a customer puts something back on the shelf.

Forget the gee whiz of Go. For the entire retail industry, the Ambition response is the agenda, with our three initial questions salient and not to be left silent: (1) Does AI change business basics or largely add to existing best practice and process? (2) How quickly, why and by how much is it reshaping the competitive landscape? And (3) How well-resourced are we organizationally and financially to respond?

4. Stock Trading

In 2000, Goldman Sachs employed 600 traders buying and selling stocks for its institutional clients. Today there are just two equity traders remaining, supported by 200 computer engineers. (in 2018 about a quarter of Goldman's employees were computer scientists). It's very clear that Goldman views AI as Transformational. Its hiring of executives, capital investments and reports on risk management, trading and service innovations make that very clear, though it maintains a high level of trade secrecy and related PR water-muddying.

It's tempting to equate AI supertech innovation with business flash and creation of newness. A senior executive in Goldman's Investment Bank, which operates in one of the most established financial service sectors, emphasizes that business Transformation may be most marked in old line

firms carrying out centuries-old operations: "The value of AI is going to show up in surprising places… mature businesses that have the business process and the data that's going to underlie the AI models of the future."

In the past few decades, computer speed and power have reshaped the basics of the transactions, with electronic trading systems shaving nanoseconds off buying and selling of securities. It's a very AI-ready environment, morphing continuously via technology and the mathematical mindset that is constantly searching for new and refined algorithms. Its history here is packed with successes, some huge failures, scandals and legal tightrope tiptoeing.

The move to AI in the forefront of innovation will be expensive, risky and likely to be marked by these same mishaps. It goes well beyond simple models. The leaders illustrate this in their descriptions of it as a platform – a launch pad and command control center. Like Goldman, JP Morgan has rolled out "LOXM" (the internal name for its platform) whose purpose is to "execute clients' orders at maximum speed at the best price by using lessons learnt from billions of past trades – both real and simulated - to tackle problems such as how to offload big equity stakes without moving the market price." ML systems are breaking the limits of human traders in this fast pace environment.

Both firms are cagy about disclosing their plans and progress in creating new Pattern Power but it's clear that they are expanding the nature of the data they can add to their institutional Intelligence capabilities. For competitors, the issue is when to lead and when to follow. JPMorgan and Goldman Sachs use the language of Transformation and are revealing the scale of their Ambition. Where does this begin to mark the industry, not just a few companies? Restated, where – if at all – in a competitive sector, does Break Away Transformation move from option to requirement?

5. Self-driving cars

In autonomous cars, the auto industry has made its Ambition decision well before there was even one vehicle on the road. This is Transformational and has already reshaped the sector. It hasn't been instant in generating results; the lead time from Break Away ambition to Take Away payoff – taking away markets, customers, money and competitive flexibility is often obscured by headlines.

A start date marker is 2004, when DARPA (The Defense Advanced Research Projects Agency) ran a Grand Challenge: a 150 mile course across the Mojave Desert for autonomous cars. None got more than 7.32 miles. In 2017 Sebastian Thrun, who was at Stanford at the time and, went on to head Google's self-driving project, said of the 2004 Challenge: "These vehicles didn't fail because they weren't rugged enough. They didn't take in enough environmental information. None of them saw anything. There was no lack of sensors - The cars were equipped with a combination of Lidar (laser light detention and ranging that calculate distances and recognize shapes by pulsing laser signals), cameras, GPS sensors. The onboard computers could not understand what the sensors were seeing." Thrun went on to say: "Very few self-driving car people knew anything about machine learning at the time". (Lidar could see a shape but had no idea what it was – a tree? a dog? child? That needed ML.)

DARPA repeated The Grand Challenge 18 months later in October 2005, doubling the prize to $2 million. When the dust cleared, all but one of the finalists had gone farther than the 7.32 upper limit for the 2004 race. Five, including the winner from Stanford, had completed the entire 132 mile course. The teams had found a better way to understand and navigate the course: Machine Learning had entered the picture, breaking limits of rule-based systems.

In 2009, a full decade ago, Google officially entered the autonomous car business. The initial Pattern Power opportunity it identified was reduction in traffic accidents. The major car companies were uninterested. Then in 2015 Uber gutted Carnegie Mellon Robotics Lab by hiring 50 professors and staff. Around that point, car companies realized that the pattern power could be extended into services like autonomous car sharing that could really transform their business.

The spin offs from the grand Ambition plans of Google, Baidu, Tesla, Ford and others have already opened up new opportunity paths. Self-navigating robots are handling "last mile" delivery of items that comprise around 20% of logistics costs with Domino's Pizza, Fedex, and Germany's national mail service, Deutschepost, just a few firms moving aggressively. Ride-sharing services are being planned piloted and rolled out in many cities. An interesting question being discussed in the home building industry is if and when there will be no value in providing a two-car garage.

Meanwhile, Waymo, Google's autonomous car division, is generating no revenue, like so many other AI ventures, and is estimated to be losing around $1 billion a year but was valued last year by Morgan Stanley at $175 billion.

6. The Smart Container:

The Smart Container: The standardized container that cargo ships carry was invented and patented in 1956 and has changed little since. Approximately 60% of all seaborne trade travels in containers. The Port of Rotterdam along with IBM, Cisco and Esri are launching Container 42 that will be able to see, feel, hear, taste, smell its environment and know its position at all times. Containers with IoT devices (Internet of Things) are not new, but the Port wants to take this many steps further. It is sending Container 42 on a two-year voyage to gather all kinds of data.

This is part of the Port's Digital Twin project with the stated ambition to become the smartest port in the world. Nothing that happens in the container's journey will go unnoticed. Everything will be recorded. But the focus is not to just build an archive of the past and know the present but also predict the future. The Port Authority sees possibilities for linking the container to the port's own processes. According to Erwin Rademaker of the Port Authority, "You can imagine that this container will talk to cranes in the future. Or that it will fill in its own customs forms, because it knows exactly where it has been and that it has not been opened."

This is a specific example of a general dynamic. Supply chain management has been built around the goods, physical locations and machines that handle operations. Information collection nad recording tools were added and evolved: bar coding, RFID tags, sensors, etc. But these have been passive accompaniments to the physical objects.

The smart container (1) breaks the limit on the types of information that can be collected, tracked and used. Odors are a key one; for foods, contamination from earlier cargos is a major problem – (2) makes every transaction and movement leave not just a static record but add to the accumulation of data the AI learns from and (3) digitalizes the physical supply chain to be managed via AI to know not only its history and status, but to make predictions so that actions can be taken where needed. Today's smart container with all of its senses is very much like the DARPA cars in 2004. Without ML to create Pattern Power, the container is not smart at all.

7. Really Fast Delivery

Amazon changed the e-commerce game with Amazon Prime and free 2-day delivery. It recently laid down the next gauntlet in announcing that it was mobilizing Prime to offer free 1-day delivery. But it is obvious that a whole day is not the final ambition. Amazon already has 493 warehouses worldwide and there is one within 20 miles of 50% of the U.S population. It currently offers 2-hour delivery in urban locations on 25,000 items that includes a delivery charge. In a 2019 article in The Economist, Udit Madan, a last-mile-delivery guru, predicted that 30 minute delivery would happen in the next five years and he would not rule out 15 minutes.

While Amazon's physical distribution network, including drones and last-mile delivery robots like the Scout, is essential to this almost unimaginable decrease in delivery time and, by necessity the associated delivery cost, the new heart of the network is AI: ML pattern power that can analyze every entity and dynamic throughout the digital supply chain – or, rather, supply digital twin – learn, make predictions and direct decisions.

AI is driving the forecast for some 750 million products to make sure that exactly the right product and size is in the right fulfillment center at the right time (that involves over 140 data points for every product for every day of the year, which is far beyond the capability of any human or rule-based system), how those products are stored within the facilities, and how each order is picked, packed and shipped, including optimizing the last mile.

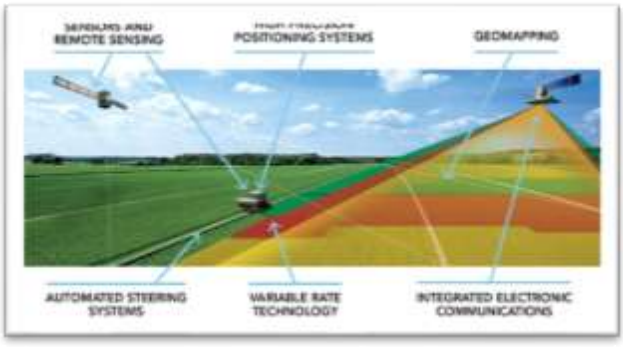
Amazon is really building an AI network that optimizes a physical network rather than a physical network overlaid with information flows.

8. Precision agriculture

AI is creating an entirely new force in the world's largest and oldest industry. Precision agriculture is the emerging mainstream of farming. It uses technology to sharpen focus, zero in on, and narrow down, for example, land mapping, soil sampling, fertilization, pest and disease control and weather alerts.

"Precision" means right down to the tightest degree of control and minimization of resource usage. One of the main limitations of farming methods has been that they must treat crops and fields as homogenous, whereas in reality every plant, row or patch may be a little or even a lot different from its neighbor. The "precision" label contrasts with "broad."

The base of PA is data resourcing: locating, collecting, organizing and putting it to use. That is apparent in its first exploitation of information- and communication-technology: GPS plus satellite imaging. This infrastructure is AI-ready. AI models are being added to the application capability across the globe, including in many remote areas of the world and being adopted by smallholders, who produce 50% of the world's food crops.



Agriculture

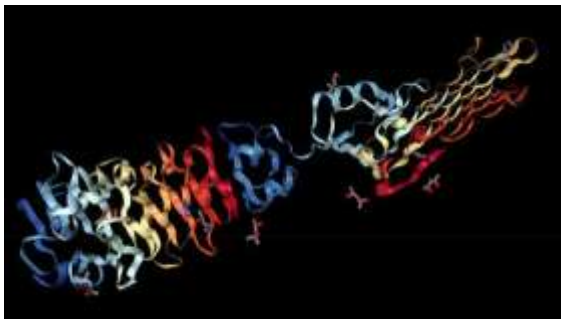
10% of global GDP, $5 trillion
1/3 of global work force, over 1 billion
570 million farms, 72% less than 1 hectare
90% family run, 60% of world food supply
1% over 50 hectares, control 65% of land
US average size is 178 hectares
Sustainability and mitigating climate change
Forecasts are consistent in estimating a needed increase in production of 70% by 2050 to meet a population growth from 7 to 9 billion

Just one striking instance of the payoff is the ability to apply fertilizer, pesticide and water to a single plant, delivered from a drone or an Internet connected tractor. The drone is a flying farmhand that, according to many reports, so accurately focuses spraying that it cuts water use by 30-50% and chemicals by 90%. Planting costs are decreased by as much as 90% and weeding time sped up by a factor of 5 with labor savings cut by a multiple of 10.

The camera sees much more and offers new mappings – Pattern Power. One of the most promising developments is heat imaging that can spot plant disease early even though the symptoms are invisible to the naked eye. By applying machine vision algorithms to drone footage, Microsoft's FarmBeats provides farmers with a digital heatmap of crop health and ground moisture. It uses multiple AI techniques to fuse aerial imagery from drones with ground sensor data, while also leveraging deep learning and machine vision on video streams to identify pests, diseases, and nutritional deficiencies in crops.

All this is beginning to reshape the Patterns of farming management. It is impossible to see how the escalating impact of climate change can be countered without precision agriculture as the core weapon or precision agriculture being more than camera mapping without AI.

9. Protein folding



Protein folding is one of the most important and mathematically intractable challenges in molecular biology. Neither rule-based software algorithms, nor massive computing calculation power or human ingenuity have made much progress in what has been described as "molecular origami." Proteins function as the essential nutrients in our bodies, building body mass and acting as fuel sources.

Each one is a chain of amino acids, of which there are twenty types. Every link in the chain makes its own connection; it may twist or bend, a little or a lot, taking a reverse, zigzag or hairpin direction. The protein's resulting shape determines its function. The typical protein is 50-1000 amino acids in length. The human body is estimated or more accurately conjectured to generate billions. The possible combinations amount to an impressive if meaningless figure: a googol cubed: 1 followed by 300 zeros.

Rapid advances in DNA analysis are identifying the chemical composition of a protein, but not the structure that determines its function. If researchers are able to predict a protein's shape, they can begin to treat it as a design variable in medical science.

CASP (Critical Assessment of Structure Prediction), the technology Olympics of protein folding, attracts research teams from around the world. The aim of the competition is to predict the structures of, for 2018, 90 proteins that have "recently been cracked by laborious and costly traditional methods" (such as x-ray crystallography) but the results are not public.

Google DeepMind was a new entrant to the competition in 2018 and won in a runaway. Leveraging its deep learning algorithms to predict 25 of the 43 structures for one group of the 90 total proteins. The runner-up correctly identified just 3. The AI design used several learning approaches in combination, with neural modes inventing and testing potential molecular jigsaw pieces.

This is an example of an insoluble problem being made tractable. Is it a major limit breaker? Absolutely. Will it change all of Healthcare? Not a chance. But that new drug development startup… The formation of a research lab by one of the food production giants… Well, maybe. And soon. These are all Pattern Power opportunities of if not unlimited then at least unconstrained potential.

10. Design your own materials

"Imagine building a bridge, not with concrete and steel, but with a completely new synthetic material fabricated with a unique blend of protein molecules similar to the ones used to produce spider web silk. Or creating a medical implant made of biomaterials that have the ability to self-heal and regenerate." According to MIT, "Machine learning, and predictive modeling, a powerful subset of AI, is being used to accelerate the discovery of these new materials. Designers simply enter the desired properties into a program and algorithms predict which chemical building blocks can be combined at a micro level to create a structure with the desired functions and properties."

The implications of this require no comment.

11. Language translation

Google's Neural Machine Translation translates over 100 language pairs. As reported in 2018 when asked to rate the translations on a scale of 0-6, mother-tongue language speakers gave it an impressive average rating of 5.43.

According to Google "The (new) AI system, (that was completed in only nine months), demonstrated overnight improvements roughly equal to the total gains the old one had accrued over its entire lifetime (10 years)" That system was rule-based. The new deep learning capability reads and renders entire sentences in one draft to capture the context, not just the words, to improve the quality of the translation. No one person can possibly know 100 languages, nor is there a translator around every time you need one.

12. Some Pattern Power Utilities

There are many other examples of the combination of Pattern Power and limit-breaking. Many of these took fifty years of sustained theoretical and empirical research before they created practical tools. Yet within five years they moved from exception to norm and off-the-shelf utilities. Siri and Alexa are examples: a consumer device feature today but an entire academy of linguistics, army of software developers, and fortress of mainframe computers for well over fifty years of piecemeal progress.

Some other now commonplace instances are:

Odors and flavors: Though humans can distinguish about a trillion odors our vocabulary is limited. Terms like "fruity" or "musky" are not only imprecise, but also colored by cultural

bias. Unlike with other senses—hearing, sight, touch, and taste—we have trouble agreeing on universal terms for smells."

IBM has created an algorithm that translates fuzzy descriptive words to their molecular equivalent, and vice versa. This can significantly help in the developments of new perfumes, food and spices and even the medical industry in diagnosing neurological disorders. Machine learning uses comparable tools to work out how people cluster and categorize flavors. This is shaping food and beverage product development, with Microsoft's TV ads highlighting it for new beers.

Face recognition: This has become one of the standard utilities in many areas of public and private sector operations. Just a few years ago it was ultra-state of the art. Now, it's routinely accessible to most organizations; the value will come from how it's targeted. It is part of general pattern recognition: faces, land features, flaws in manufacturing parts and even cows – large farms use it to track the health and location of every part of a herd.

Is it transformational? For police agencies, it is seen as very much so; the ability to make early identification, pick out suspects who have changed some aspects of their appearance and link to surveillance cameras.

For most companies, it is narrower in potential. It also runs up against many barriers: bias in the data samples used to train the models, invasion of privacy and unexpected errors in interpretation. An old trick in fooling an image recognition system was to paste a picture of, say, a beer can on one of a fridge. The system could easily recognize either but both together bewildered it. As for one major player in self-driving cars, how about handling real-time imaging of the cyclist carrying a large Stop sign on his or her back?

Image Search: Humans have been communicating with images since at least 30,000 BC, while written language only dates back to 3000-4000 BC. As a result, the human brain has more innate image processing dexterity than word processing capability. The next time you drive down the highway, note how many images you automatically take in versus how much time it takes to read a billboard.

But without AI, search engines have been limited to numeric, text input or strictly formatted graphics. In many ways, throughout their first fifty years of development, computers removed rather than added to "information." The limit here was alphanumeric digital coding – bits and bytes – to represent and manipulate data.

There are no such limits now. The demand for image data is escalating. Pinterest's Lens tool hosted 250 million visual searches in February 2017, and 600 million in February 2018.

The individual and generic examples can be multiplied many times over. Here's an impressionistic summary of limits being broken and the value delivered by ML Pattern Power. Note the heading on the Limits column "To date."

Example	Limits Broken, to Date	ML Pattern Power
1. Watson and Jeopardy	Extend search and enquiry of digitized data to natural language End virtual exclusion of the written word from software processing	Deepen knowledge access Expand volumes and variety of information that can be incorporated in analysis, forecasts and query
2. Medical imaging	Time to train a human specialist, the time required for one to analyze an image and recognize an abnormality	More of every important element: more detail, more precision, more examples to learn from Better, faster diagnosis

	Reliance on the total number and skills of specialists available	
3. No Checkout	Eliminating some of the roughly 115 hours people waste annually waiting in line, without imposing self-checkout that simply transfers the cashier's duties to the customer and that many customers hate	Using cameras and ML image recognition to recognize what a shopper has placed and kept in their brick and mortar store basket and properly charging their account all with no checkout
4. Equity Trading	The number and cost of traders required to make large equity transactions	Using algorithms to package and offload large equity stakes at maximum speed at the best price without moving the market
5. Autonomous Cars	Enable vehicle to apprehend in real-time everything that is happening to and around it	The development discovered, and yet to be discovered, ways to leverage driverless vehicles such as ride sharing and last mile delivery Learn by experience what we cannot teach by rules
6. Smart Shipping Container	Detachment of goods from the dynamics of supply chain integration	Information moves with the goods All elements of condition and status automatically available Being able to predict future states and take decisions accordingly
7. Really Fast Delivery	Dramatically reduce the time and cost for delivery of retail goods Remove waste in logistics Synchronize demand-supply coordination	Create an AI network that drives and optimizes a physical goods distribution network with order to delivery times in 1-2 hours or less
8. Precision Agriculture	Resolve farmer's dilemma of never enough data to capture conditions that affect crops, always too much to process	Maps, maps, maps of soil, weather, crops, disease Higher crop yield with fewer resources
9. Protein Folding	Replace today's very intensive process to discover protein shapes from the wealth of amino acid sequence information being created by DNA advances.	Develop new drugs and materials. Conceptualization and analytic methods that incorporate the most advanced mathematical thinking
10. Design Own Material	Not having to force fit an existing material to serve a purpose for which it may be over- or under-configured	Abstract design of material functionality without physical constraints Discover new chemical syntheses
11. Language Translation	Human need and capacity to know multiple languages to enable communication and learning. Inability to solve this with rule-based systems.	Google's Deep Learning system translates in real time over 100 language pairs with and estimated accuracy of 5.43 on a scale of 0-6
12. Utilities	Remove barriers to fuller exploitation of computer power, data access End rule-based dominance in tool-specification	Balance, leverage, fuse human and machine capabilities

The "To date" is a reminder that breaking limits is not a one-time event. For all the progress to date, there remain many constraints on AI Pattern Power and many opening opportunities, too. It's key to repeat that AI tools have their own limits, often unacknowledged or even unrecognized. A critical consideration in assessing the likely Transformational pace and impact of AI is which of these will be the next to see breakthroughs. We just don't know. The question centers on just what the "I" in AI really means for action, not machine IQ.

For executives, there is obviously no way they can keep track of such progress, but what they can do is focus on the business-impacting Intelligence limits that they see as priority. For many, these are centered on customer relationships. For others, they relate to product development, design, supply chain integration. They should avoid two common traps: (1) Approving AI strategies that may produce short-term payoffs but relatively quickly hit their Transformation limit and (2) Setting overambitious targets that omit the need to continuously address the issues that the "academic" Neaties warn about.

Target the business limits to extend, push or work within. Then, make sure you source the capabilities through a combination of in-house, relationships with the pace-setters, collaborators, joint ventures and sharing of the masses of data that machine learning makes essential. Don't start with the AI development package and wait until it hits a key Intelligence limit.

All elements of strategy, application targets, tools and data rest, of course, on the core issue of is AI truly Transformative?

The leadership challenge: Set the Ambition, not define the strategy

The short selection of examples in this briefing paper sets up the single most consequential question for executive leadership: Ambition. Even though they can't predict, managers can set the directional goal and level of commitment. If AI is Transformational, in the way that, say, e-commerce was for retailing, then it is not sensible to move with the pack. The Ambition has to be to look for ways to Break Away. If, as with precision agriculture, there is no one AI thrust that changes the very identity of the industry, but the evidence points to an inevitable long-term AI-led transformation, then the Ambition needs to be more one of positioning for constant waves of change that Morph the business into a new living form. Finally, if AI looks like paralleling social media in a wide-ranging variety of applications with many of yesterday's innovations becoming today's utilities and off-the-shelf purchases, Augment the business as you go. Cherry-pick low-hanging fruit.

Breakaway? Morph? Augment? It's the leaders' choice.