Technology Overview

Artificial Intelligence

Definition

- AI, is characterized as “deep learning” techniques using artificial neural networks, and can be used to solve a variety of problems.
- Artificial intelligence is rapidly becoming essential for enhancing the productivity of industrial operations, as it enables producers to reduce conversion costs by up to 20%.
- AI is generating real value across industries, both in new offerings and in internal productivity improvements
- The gap between leaders and laggards is widening: While many believed the increasing adoption of AI may level the playing field, the reverse is true. 88% of Pioneers have increased their AI investments over the last year, compared with 62% of Investigators and Experimenters and 19% of Passives.
- While many discussions of AI in business focus on productivity and automation, the reality is different: Pioneers say 72% of the business value they are generating from AI comes in the form of increased revenues.
- Chinese pioneers invest more aggressively in AI: 91% of Chinese pioneers have made significant AI investments over the past year, compared with 74% of their peers in the US and Europe. In the rest of the world, the share of Pioneers with significant AI investments was 65%. In China, 60% of pioneers have already modified their business models, compared with 53% in the US, 47% in Europe and 48% elsewhere.

Application

- classification, estimation, and clustering problems are currently the most widely applicable
- focused on specific potential applications of AI in business and the public sector (sometimes described as “artificial narrow AI”) rather than the longer-term possibility of an “artificial general intelligence”

1. Reinforcement learning
    a. subfield of machine learning in which systems are trained by receiving virtual “rewards” or “punishments,” essentially learning by trial and error
    b. Google DeepMind used reinforcement learning to develop systems that can play games, including video games and board games such as Go, better than human champions.

2. Classification
    a. Based on a set of training data, categorize new inputs as belonging to one of a set of categories.
    b. Example whether an image contains a specific type of object, such as a truck or a car, or a product of acceptable quality coming from a manufacturing line.
    c. Anomaly detection

3. Continuous estimation
    a. Based on a set of training data, estimate the next numeric value in a sequence.
    b. sometimes described as “prediction,” particularly when it is applied to time series data.
    c. example of continuous estimation is forecasting the sales demand for a product, based on a set of input data such as previous sales figures, consumer sentiment, and weather

4. Clustering
    a. These problems require a system to create a set of categories, for which individual data instances have a set of common or similar characteristics.

5. All other optimization
    a. These problems require a system to generate a set of outputs that optimize outcomes for a specific objective function

6. Ranking algorithms
    a. most often in information retrieval problems in which the results of a query or request needs to be ordered by some criterion.
    b. Recommendation systems suggesting next product to buy use these types of algorithms as a final step, sorting suggestions by relevance, before presenting the results to the user.

7. Data generation
    a. generate appropriately novel data based on training data.
    b. music composition system might be used to generate new pieces of music in a particular style, after having been trained on pieces of music in that style.

Technology

- feed forward neural networks, recurrent neural networks, and convolutional neural networks—account for about 40 percent of the annual value potentially created by all analytics techniques.
- enable the creation of between $3.5 trillion and $5.8 trillion in value annually.
- Neural networks are a subset of machine learning techniques
- Essentially, they are AI systems based on simulating connected “neural units,” loosely modeling the way that neurons interact in the brain.
- AI practitioners refer to these techniques as “deep learning,” since neural networks have many (“deep”) layers of simulated interconnected neurons.
- Before deep learning, neural networks often had only three to five layers and dozens of neurons; deep learning networks can have seven to ten or more layers, with simulated neurons numbering into the millions.

1. Feed forward neural networks

    a. most common types of artificial neural network. In this architecture, information moves in only one direction, forward, from the input layer, through the “hidden” layers, to the output layer. There are no loops in the network.

2. Recurrent neural networks (RNNs)
    a. Artificial neural networks whose connections between neurons include loops, well-suited for processing sequences of inputs, which makes them highly effective in a wide range of applications, from handwriting, to texts, to speech recognition.

3. Convolutional neural networks (CNNs)
    a. Artificial neural networks in which the connections between neural layers are inspired by the organization of the animal visual cortex, the portion of the brain that processes images, well suited for visual perception tasks.

4. Generative adversarial networks (GANs)
    a. These usually use two neural networks contesting each other in a zero-sum game framework (thus “adversarial”). GANs can learn to mimic various distributions of data (for example text, speech, and images) and are therefore valuable in generating test datasets when these are not readily available.
    b. virtual learning environments in which algorithms train one another to solve problems—such as creating and discriminating false pictures of faces.

History

1. Warren McCulloch and Walter Pitts, who as early as 1943 proposed an artificial neuron, a computational model of the “nerve net” in the brain.
2. Bernard Widrow and Ted Hoff at Stanford University, developed a neural network application by reducing noise in phone lines in the late 1950s.
3. In 1986, Geoffrey Hinton at the University of Toronto, along with colleagues David Rumelhart and Ronald Williams, solved this training problem with the publication of a now famous back propagation training algorithm—although some practitioners point to a Finnish mathematician, Seppo Linnainmaa, as having invented back propagation already in the 1960s.
4. Yann LeCun at NYU pioneered the use of neural networks on image recognition tasks and his 1998 paper defined the concept of convolutional neural networks, which mimic the human visual cortex.
5. This was subsequently expanded upon by Jurgen Schmidhuber and Sepp Hochreiter in 1997 with the introduction of the long short-term memory (LSTM), greatly improving the efficiency and practicality of recurrent neural networks.
6. At the same time, Jeffrey Dean and Andrew Ng were doing breakthrough work on large scale image recognition at Google Brain. Deep learning also enhanced the existing field of reinforcement learning, led by researchers such as Richard Sutton, leading to the game-playing successes of systems developed by DeepMind.

7. In 2014, Ian Goodfellow published his paper on generative adversarial networks, which along with reinforcement learning has become the focus of much of the recent research in the field.

But implementation has not kept pace with expectations, in large part because many companies lack the four key enablers of AI:

1. Strategy and Roadmap. In order to provide direction and guidance for all of its AI implementation activities, a company needs to have a clear strategy.

2. Governance Model. A visible commitment by management is critical to realizing potential improvement. Top management should use structured communications to ensure a clear understanding of AI within the organization. The company should establish clear roles and responsibilities for AI implementation and devise a clear organizational structure.

3. Employee Competencies. To adopt AI—and digitization in general—a company must have employees with strong skills in programming, data management, and analytics, among other competencies. A company should have a clear idea of the skill sets it requires and should assess the gaps between those needs and the skills its employees currently possess.

4. IT Infrastructure. The interoperability of legacy IT systems and machinery equip ment, promoted by application programming interfaces and network standards, is crucial to the success of AI implementation. Cybersecurity is another important concern of practitioners working with AI and Industry 4.0 generally.

Step-by-step:

1. Assess the status quo. A company should start by evaluating its pain points and AI maturity, and then it should benchmark its current state against that of its peers or against the industry average. Because robust IT infrastructure is essential for AI implementation, the company must assess the current state of its operations IT.

2. The company should develop a comprehensive list of AI use cases to address the pain points identified during the health check. All stakeholders should meet in workshops to discuss the use cases in depth and to determine which ones to prioritize for implementation.

3. Input from AI experts who have experience in quantifying the benefits and required investments can be extremely valuable at this stage. After identifying the priority use cases, the company can develop a target picture for AI in operations and create a roadmap for implementation.

4. Test and scale up solutions. The company should test AI uses cases in specific parts of the plant. To accelerate the process, it should initiate its first pilot programs at the same time that it is defining a vision and establishing enablers. The objective of each pilot

should be to quickly develop a minimum viable solution and then, through agile development methods, to improve the pilot's design over multiple iterations

AI represents a paradigm shift for the factory. Today's factory automates processes and machinery through a rules-based approach, and today's robotics programming addresses a fixed set of scenarios. In contrast, the factory of the future will use AI support to automate processes and machinery to respond to unfamiliar or unexpected situations by making smart decisions.

37% rated production as the area of factory operations in which AI is the most important lever for productivity improvement, while 25% rated quality highest and 12% chose logistics highlight

Engineering. Producers can use AI to promote R&D efforts that optimize designs, improve responsiveness to customer demand and expectations, and simplify production. AI supports generative product design, in which algorithms explore all possible design solutions on the basis of defined goals and constraints. Through iterative testing and learning, AI algorithms optimize designs and suggest solutions that may appear unconventional to the human mind.

Supply Chain Management. Demand forecasting is a key topic for applying AI within supply chain management. By better anticipating changes in demand, companies can efficiently adjust production programs and improve factory utilization.

Production. Our study covered the full range of production environments, including continuous processes (such as those for producing chemicals and building materials) and discrete production (such as assembly tasks). In all environments, producers will use AI to reduce cost and increase speed, thereby boosting productivity

Maintenance. Producers will use AI to reduce equipment breakdowns and increase asset utilization. AI supports predictive maintenance—for example, avoiding breakdowns by replacing worn parts on the basis of their actual condition. AI will continuously analyze and learn from data that machines and units (for example, sensor data and product mix) generate

Quality. Producers can use AI to help detect quality issues as early as possible. Vision systems use image-recognition technology to identify defects and deviations in product features.

Logistics. Our study focused on in-plant logistics and warehousing, rather than on logistics along the external supply chain. AI will enable autonomous move ment and efficient supply of material within the plant, which is essential to managing the growing complexity that comes with making multiple product variants and customer-tailored products

Strategy setting in an era of disruption is daunting, and AI is the epitome of disruption. So while it makes sense to initiate an AI strategy within or close to the current business model, companies must also take into account the evolution of value pools in the wider market as other players embrace AI.

For example, Uber's Michelangelo, in the words of the company, is "an end-to-end system that enables users across the company to easily build and operate machine learning systems at scale." (See Exhibit 2.) Likewise, a leading European online fashion retailer has built an AI platform that allows individual AI systems to work together and reuse components.
Moreover, companies need to ensure that they have the storage, computing, and bandwidth to handle multiple AI engines and their timely actions. Owing to its flexibility, the cloud is often a preferred option to address these needs
Consequently, many companies expanding their AI operations need only a small number of data scientists and AI experts at the core but require a large number of data and systems engineers with AI experience to ensure the performance and resilience of the pipeline and peripheral systems.
Executives should view these options in light of two questions:

- How valuable is the process or offering to our future success?
- How strong is our ownership, control, or access to high-quality, unique data, relative to the AI vendor's?

The most immediate need is critical technical skills. While many companies focus on hiring data scientists, they are encountering a greater shortage of people who have both business skills and an understanding of AI, as well as systems and data engineers, as mentioned earlier.

Data is the raw material of AI, but it also contains some of the company's most sensitive information. A world-class data governance function, which sets data permissions across the organization, is critical in an AI world, to ensure both competitive advantage and regulatory compliance.

Virtual Reality

Blockchain

Definition

- blockchain is a shared digital ledger for recording and storing transactions between multiple participants in a network
- Blockchain's value comes from its network effects
- The most impressive results have seen blockchains used to store information, cut out intermediaries, and enable greater coordination between companies, for example in relation to data standards.
- Occam's razor is the problem-solving principle that the simplest solution tends to be the best. On that basis blockchain's payments use cases may be the wrong answer.
- There are specific use cases for which blockchain is particularly well-suited. They include elements of data integration for tracking asset ownership and asset status. Examples are found in insurance, supply chains, and capital markets, in which distributed ledgers can tackle pain points including inefficiency, process opacity, and fraud
- changes made to the blockchain record must be approved by participants through an automated process
- Modernization value: Blockchain appeals to industries that are strategically oriented toward modernization. These see blockchain as a tool to support their ambitions to pursue digitization, process simplification, and collaboration. In particular, global shipping contracts, trade finance, and payments applications have received renewed attention under the blockchain banner. However, in many cases blockchain technology is a small part of the solution and may not involve a true distributed ledger.
- approved updates are time-stamped, cryptographically signed, and added to the block; the new block becomes part of the blockchain.
- Unlike traditional ledgers, a blockchain provides an immutable record of all transactions and agreements of interest to the participants—no single party can unilaterally alter the information. Because information cannot be deleted, only appended, a blockchain provides an evidentiary trail of information back to the point of origin.
- The best blockchain networks are often the hardest to create. A fundamental paradox relating to blockchain technology is on full display in the transportation and logistics (T&L) industry. By increasing transparency, these distributed digital ledgers can mitigate the mistrust that often exists among the industry's transacting parties. Yet this same mistrust makes it hard to bring together the industry's diverse participants into a common blockchain ecosystem.
- On its own, a blockchain is not a panacea—it can only serve as a repository of data and a means to automate transactions. To enable other benefits, blockchain should be used in combination with other technologies. The embedded sensors and networked devices that make up the Internet of Things (IoT) can automate the capturing and transmission of machine-generated data, and artificial intelligence and machine learning can be used to analyze data and derive powerful insights.
- By providing a single version of the truth for all participants, a blockchain enables trustless transactions and reduces the risk of error or fraud and the need for intermediaries. Participants gain the ability to track the movement of items in real time

and verify transactions. A blockchain ledger can also be used to set up a wide range of "smart" contracts that self-execute upon the occurrence of a specified scenario (for example, peer-to-peer payment upon delivery of goods), thereby automating repetitive processes.

Use Case

- Simply put, because blockchains create data transparency, they help to establish trust among participants in complex networks. And, although the data entered in a blockchain is not guaranteed to accurately represent reality, data in a well-designed blockchain cannot be tampered with.
- Blockchains can be public, private, or hybrid
    - A public blockchain (bitcoin, for example) is open, so that anyone with computing capacity can add to the network, maintain the ledger, and weigh in on issues requiring consensus.
    - In contrast, private blockchains are run by one business, joint venture, consortium, or government entity. Although the controlling party cannot alter data, it has the ultimate say in the rules that govern the platform, including who can join and which members can view or append information in the digital ledger.
    - Hybrid blockchains are controlled by a consortium of businesses or government entities that may give access to the public to view or append information or may restrict access to its members. A private or hybrid blockchain with permissioned access (that is, only authorized users can join and read and write data) provides the highest level of scalability and data privacy. Private or hybrid blockchains can be set up to require far less computing power than public blockchains.

Leading T&L players are beginning to explore ways to capture value from blockchains, both on an individual basis and in cross-industry collaborations. Notable examples include the following:

- A consortium of nine companies is developing a blockchain-enabled platform called the Global Shipping Business Network, with the goal of improving speed, transparency, and collaboration and promoting digitization. Participants include carriers (CMA CGM, COSCO Shipping Lines, Evergreen Marine, OOCL, and Yang Ming); terminal operators (DP World, Hutchison Ports, PSA International, and Shanghai International Port); and a software solutions provider (CargoSmart). • Anheuser-Busch InBev, Accenture, APL, Kuehne + Nagel, and a European cus toms organization are collaborating in a cross-industry initiative to explore the application of blockchain to support documentation handling for ocean freight.
- Maersk and IBM have jointly created TradeLens, a blockchain-enabled shipping solution designed to promote more efficient and secure global trade. The objective is to support information sharing and transparency across the value chain and encourage innovation.
- The Blockchain in Transport Alliance seeks to drive industry-wide blockchain adoption. The alliance is a consortium of approximately 400 members spanning

- Another example is a startup called Provenance, which is working with Indonesian fishermen to use blockchains and smart-tagging technology to verify sustainability claims regarding the fish they bring to market. Such applications enable companies to not only increase supply chain process efficiency but also enhance compliance and support a brand's reputation and quality, which ultimately protect premium price points.

Implementation

1. To catalyze the development of the ecosystem, a company or group of companies must serve as an orchestrator.
2. Policies need to address regulatory considerations, such as laws, international privacy standards, and requirements for data sharing.
3. Stake holders also must establish rules for authenticating the identity of network participants and agree on whether anonymity is permitted
4. Governance and Decision Rights. The stakeholders must establish clear governance that articulates their respective roles and decision rights in the continuous development and evolution of the blockchain platform.
5. Commercial Considerations. Commercial considerations include the costs of designing, implementing, operating, and maintaining the solution and how the costs will be shared among stakeholders.
6. Clear Value Proposition. All players need to see and share the value created from the common adoption of blockchain. To give visibility to the opportunities, the ecosystem must develop a value proposition that addresses the concerns of the main stakeholders. Shippers and carriers have tight profit margins and seek new ways to reduce their cost base.

To get there we see three key principles as minimum conditions for progress: • Organizations must start with a problem. Unless there is a valid problem or pain point, blockchain likely won't be a practical solution. Also, Occam's razor applies—it must be the simplest solution available. Firms must honestly evaluate their risk-reward appetite, level of education, and potential gain. They should also assess the potential impact of any project and supporting business case. There must be a clear business case and target ROI: Organizations must identify a rationale for investment that reflects their market position and which is supported at board level and by employees, without fear of cannibalization. Companies should pragmatically consider their power to shape ecosystems, establish standards, and address regulatory hurdles, all of which will inform their strategic approach.

Augmented Reality

Internet of Things

- Value it will eventually create may be almost unfathomable—like a second internet, some analysts have said.

- Hardest part of IoT is learning how to apply it
- Most companies say they are still working on a new business model to capitalize on the greater insight IoT applications will give them into their customers and the performance of their offering.
- Fortunately, the interactive nature of the connection, which will enable the product to become more intelligent over time, and the granular lifecycle knowledge IoT can yield, will make this kind of brand promise easier to sustain.

- For consumer- -focused companies, this subscription model will undoubtedly be important, but, as with the internet, the consumer data itself may become so valuable that it leads to a reassessment of the rest of the pricing equation.

- For telco service providers, IoT presents an existential conundrum. Billions of IoT devices, generating exabytes of data, are projected to come online, creating unprecedented demand for connectivity and new telco services.
- From this new foundation, some telcos see themselves evolving into high- volume, low -cost commodity connectivity providers. Others are investigating higher- margin alternatives, experimenting with new business models such as vertically integrated IoT application stacks, platforms as a service, and managed services offerings.

Use Cases

- For now, three use cases are currently driving IoT adoption and growth and will continue to do so through 2020: predictive maintenance, automated inventory management, and selfoptimized production
- On top of this, many companies will need to choose an IoT platform. Some providers are focused on serving particular verticals while others focus on serving a particular layer of the IoT stack. This is a thorny decision with no easy answer.

Predictive maintenance: the power of machine learning to detect anomalies. Some existing predictive maintenance systems have analyzed time series data from Internet of Things (IoT) sensors, such as those monitoring temperature or vibration, in order to detect anomalies or make forecasts on the remaining useful life of components.

AI-driven logistics optimization can reduce costs through real-time forecasts and behavioral coaching. Application of AI techniques such as continuous estimation to logistics can add substantial value across many sectors. AI can optimize routing of delivery traffic, thereby improving fuel efficiency and reducing delivery times
Application of AI techniques such as continuous estimation to logistics can add substantial value across many sector

AI can be a valuable tool for customer service management and personalized marketing. Improved speech recognition in call center management and call routing by applying AI techniques allow a more seamless experience for customers—and more efficient processing

In 69 percent of the use cases we studied, deep neural networks can be used to improve performance beyond that provided by other analytic techniques.
Cases in which only neural networks can be used, which we refer to here as “greenfield” cases, constituted just 16 percent of the total. For the remaining 15 percent, artificial neural networks provided limited additional performance over other analytics techniques, among other reasons because of data limitations that made these cases unsuitable for deep learning.

As the size of the training data set increases, the performance of traditional techniques tends to plateau in many cases. However, the performance of advanced AI techniques using deep neural networks, configured and trained effectively, tends to increase.
Deep learning methods require thousands of data records for models to become relatively good at classification tasks and, in some cases, millions for them to perform at the level of humans. By one estimate, a supervised deep-learning algorithm will generally achieve acceptable performance with around 5,000 labeled examples per category and will match or exceed human level performance when trained with a data set containing at least 10 million labeled examples.

Nonetheless, our research shows that almost three-quarters of the impact from advanced analytics is tied to use cases requiring millions of labeled data examples. This means that organizations will have to adopt and implement strategies that enable them to collect, integrate, and process data at scale.

We estimate that the AI techniques we cite in this report—feed forward neural networks and convolutional neural networks—together have the potential to create between $3.5 trillion and $5.8 trillion in value annually across nine business functions in 19 industries.

The total annual value potential of AI alone across 19 industries and nine business functions in the global economy came to between $3.5 trillion and $5.8 trillion. This constitutes about 40 percent of the overall $9.5 trillion to $15.4 trillion annual impact that could potentially be enabled by all analytical techniques (Exhibit 10).

THE BIGGEST VALUE OPPORTUNITIES FOR AI ARE IN MARKETING AND SALES AND IN SUPPLY-CHAIN MANAGEMENT AND MANUFACTURING

From the use cases we have examined, we find that the greatest potential value impact from using AI are both in top-line-oriented functions, such as marketing and sales, and in bottomline-oriented operational functions, including supply-chain management and manufacturing (Exhibit 11).

Indeed, marketing and sales and supply-chain management together constitute some of the biggest areas of opportunity for AI (Exhibit 12).

This is because of the ease with which these platforms collect customer information, such as click data or time spent on a web page, and can then customize promotions, prices, and products for each customer dynamically and in real time. For their part, brick-and-mortar retailers can implement AI applications to improve product assortment and inventory management per store, and to optimize their supply chains end-to-end.

Given the wide range of applicability of AI techniques, broadly speaking, if you want to know where AI can create the most value, you need to follow the money. For industries in which the main drivers of value are related to marketing and sales, including many consumer-facing industries, that is where the greatest value from deploying AI can be found. However, for industries in which the key driver of value is operational excellence, such as in advanced manufacturing and oil and gas, functions such as supply chain and manufacturing are those in which AI can create the most value.

Limitations include the need for massive data sets, difficulties in explaining results, generalizing learning, and potential bias in data and algorithms
Organizations planning to adopt significant deep learning efforts will need to consider a spectrum of options about how to do so. The range of options includes building a complete in-house AI capability either gradually in an organic way or more rapidly through acquisitions, outsourcing these capabilities, or leveraging AI-as-a-service offerings.

For AI technology provider companies Many companies that develop or provide AI to others have considerable strength in the technology itself and the data scientists needed to make it work, but they can lack a deep understanding of end markets. This is a challenge, since our research has shown that most of the potential impact of AI comes from improving the performance in existing use cases—in other words, the fundamental drivers of the businesses of their potential customers.
For companies adopting AI to transform and power their own businesses
Many companies seeking to adopt AI in their operations have started machine learning and AI experiments across their business—and are likely to be bombarded by technology companies

trying to sell them “AI solutions.” Before launching more pilots or testing solutions, it is useful to step back and take a holistic approach to the issue, moving to create a prioritized portfolio of initiatives across the enterprise, including AI and the wider analytic and digital techniques available.

For policy makers Policy makers will need to strike a balance between supporting the development of AI technologies and managing any risks from bad actors, as well as irresponsible use of AI techniques and the data they employ.

AI IN BUSINESS

- The leaders not only have a much deeper appreciation about what's required to produce AI than laggards, they are also more likely to have senior leadership support and have developed a business case for AI initiatives.

- Airbus turned to artificial intelligence. It combined data from past production programs, continuing input from the A350 program, fuzzy matching, and a self-learning algorithm to identify patterns in production problems.
- In some areas, the system matches about 70% of the production disruptions to solutions used previously — in near real time. Evans describes how AI enables the entire Airbus production line to learn quickly and meet its business challenge: What the system does is essentially look at a problem description, taking in all of the contextual information, and then it matches that with the description of the issue itself and gives the person on the floor an immediate recommendation. The problem might be new to them, but in fact, we've seen something very similar in the production line the weekend before, or on a different shift, or on a different section of the line. This has allowed us to shorten the amount of time it takes us to deal with disruptions by more than a third.

Operations and manufacturing:

Customer-facing activities

- Ping An Insurance Co. of China Ltd., the second-largest insurer in China, with a market capitalization of $120 billion, is improving customer service across its insurance and financial services portfolio with AI. For example, it now offers an online loan in three minutes, thanks in part to a customer scoring tool that uses an internally developed AI-based face-recognition capability that is more accurate than humans. The tool has verified more than 300 million faces in various uses and now complements Ping An's cognitive AI capabilities including voice and imaging recognition.

- despite high expectations, business adoption of AI is at a very early stage: There is a disparity between expectation and action. Although four in five executives agree that AI is a strategic opportunity for their organization, only about one in five has incorporated AI in some offerings or processes

- The differences in adoption can be striking, particularly within the same industry. For example, Ping An, which employs 110 data scientists, has launched about 30 CEO-sponsored AI initiatives that support, in part, its vision "that technology will be the key driver to deliver top-line growth for the company in the years to come," says the company's chief innovation officer, Jonathan Larsen.

1. Pioneers (19%): Organizations that both understand and have adopted AI. These organizations are on the leading edge of incorporating AI into both their organization's offerings and internal processes.
2. Investigators (32%): Organizations that understand AI but are not deploying it beyond the pilot stage. Their investigation into what AI may offer emphasizes looking before leaping.
3. Experimenters (13%): Organizations that are piloting or adopting AI without deep understanding. These organizations are learning by doing.
4. Passives (36%): Organizations with no adoption or much understanding of AI

- Taking advantage of AI opportunities requires organizational commitment to get past the inevitable difficulties that accompany many AI initiatives.

Evans of Airbus makes the critical distinction: "Well, strictly speaking, we don't invest in AI. We don't invest in natural language processing, we don't invest in image recognition. We're always investing in a business problem."

- Perhaps the most telling difference among the four maturity clusters is in their understanding of the critical interdependence between data and AI algorithms. Compared to Passives, Pioneers are 12 times more likely to understand the process for training algorithms, 10 times more likely to understand the development costs of AI-based products and services, and 8 times more likely to understand the data that's needed for training AI algorithms.

- Our research revealed several data-related misconceptions. One misunderstanding is that sophisticated AI algorithms alone can provide valuable business solutions without sufficient data.

- Sophisticated algorithms can sometimes overcome limited data if its quality is high, but bad data is simply paralyzing. Data collection and preparation are typically the most time-consuming activities in developing an AI-based application, much more so than selecting and tuning a model

- For every new project that we build, there's an investment in combining the data. There's an investment sometimes in bringing in new sources to the data platform. But we're also able to reuse all of the work that we've done in the past, because we can manage those business objects effectively. Each and every project becomes faster. The upfront costs, the nonrecurring costs, of development are lower.

- The need to train AI algorithms with appropriate data has wide-ranging implications for the traditional make-versus-buy decision that companies typically face with new technology investments. Generating value from AI is more complex than simply making or buying AI for a business process. Training AI algorithms involves a variety of skills, including understanding how to build algorithms, how to collect and integrate the relevant data for training purposes, and how to supervise the training of the algorithm.

- Unsurprisingly, respondents at Pioneer organizations rate their companies higher in several general management and leadership areas: vision and leadership, openness and ability to change, long-term thinking, close alignment between business and technology strategy, and effective collaboration

- **Joi Ito, head of the MIT Media Lab, contends that "every manager has to develop an intuitive understanding of AI."** 5

- To develop their understanding of digital, many executives have taken trips to Silicon Valley to experience digital natives, design-thinking approaches, fail-fast cultures, and more. While these are all core to building digital businesses, such trips are not particularly rewarding to learn about AI. For those who have already been exposed to the marvels of robots, self-driving vehicles, or poker-playing machines, there is little new to experience at AI companies.

- Instead, managers should take some time to learn the basics, possibly starting with simple online courses or online tools. They should understand how programs learn from data, maybe the most important facet of understanding how AI can benefit a particular business.

highlight [page 12]: Challenge 2: Organize for AI Adopting AI broadly across the enterprise will likely place a premium on soft skills and organizational flexibility that enable new forms of collaboration, including project teams composed of humans and machines.

highlight [page 12]: Pioneers are relatively evenly split among centralized, distributed, and hybrid organizational models.

- Ultimately, a hybrid model may make the most sense since many companies need AI resources both centrally and locally. TIAA, for example, has an analytics center of excellence and a number of decentralized groups. "The center of excellence is not intended to be the group that will provide all analytics for the entire organization. It provides expertise, guidance, and direction to other internal teams that are working to deploy AI and analytics," says TIAA's Elliott.

- Ensure customer trust. AI capabilities are similar to many digital initiatives that depend on both customer data and customers' trust that the company will respect and safeguard their personal data. Ensuring that AI is trustworthy is different from other data-dependent digital initiatives, however, in several ways. First, managers may not be able to explain exactly how a customer's personal data is being used to produce a certain outcome from an AI product.

Perform an AI health check

1. As with many digital initiatives, success with AI depends on access to data sources, be they existing internal or external data or investments in data infrastructure.

2. Brace for uncertainty. The adage “No idea is born good; you have to nurture it over time” applies to AI as well as to digital technologies — only more so. Companies often prioritize their initiatives by estimating the value of, and time required for, establishing a process or offering. But hard estimates are particularly difficult with AI.

3. Attracting and developing people who combine both business and technical skills will be critical, as will the ability to deploy cross-functional teams, requiring both individual and organizational flexibility.

4. By a similar margin, respondents hope that AI will take over some of their presumably boring and unpleasant current tasks. However, respondents overwhelmingly agree that AI will both require employees to learn new skills within the next five years and augment their existing skills.

Even with rapid advances,” says Erik Brynjolfsson, Schussel Family Professor at the MIT Sloan School of Management, **“AI won’t be able to replace most jobs anytime soon. But in almost every industry, people using AI are starting to replace people who don’t use AI, and that trend will only accelerate.”**

- Managers expect significant improvement in performance of current processes or products from AI. Many companies are focused on addressing those. However, mere improvement does not create a sustainable competitive advantage — when everyone finds the same efficiencies, only the baseline shifts. For AI to become a prominent feature in future strategies, companies must figure out how humans and computers can build off each other’s strengths to create competitive advantage

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- This is not easy: Companies need privileged access to data — which, as we’ve seen, many do not now have. They must learn how to make people and machines work effectively together — a capability relatively few Pioneers have at present. And they need to put in place flexible organizational structures, which means cultural changes for both company and employee.