# ARTIFICIAL INTELLIGENCE

Just as those scientists looked to the stars for signs of intelligent life, investing has for decades looked to computers and quantitative methods for signs of Artificial Intelligence that can help make smarter decisions. But after decades, finance is confronted with a similar paradox.

There is a persistent dream of putting an AI-driven version of Warren Buffett in every investment team, one with all the positive qualities but none of the negative biases and behavioral errors that come pre-installed in humans.

The excitement of building such a revolutionary computer-based system to pick investments has driven billions of dollars of investment into building systems and hiring big-brained PhDs. The share of job openings in finance that are computer or math driven has nearly quadrupled since the Great Financial Crisis.

But most actively managed assets are still non-quantitative in nature Despite all the investments, decades of academic papers, computer systems, and fortunes made in quant investing, the vast majority of actively managed assets are still non-quantitative in nature.

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Traditional active managers will tell you quantitative techniques are not long-term enough and question how a diverse portfolio can really know anything about the “risk” of a company.

Quantitative practitioners will fire back with a long dated backtest or logic derived from perhaps flawed statistical techniques and say, “Isn’t it obvious that quantitative techniques are superior to anecdote and heuristic-driven investment?”

The two schools of thought are seemingly opposed and have spent the better part of seven decades without reconciliation. Sure, some quantitative techniques have permeated into risk management or screening for stocks − but there is no AI analyst working side by side with humans to make investment decisions better. Why not?

Combining human-driven investment research with enhancement from a junior AI researcher could leverage the best of both worlds. A team like that would combine the long-term, complex thinking of a human with unbiased quantitative evidence based decision making of AI.

Combining humans with AI to perform investment research seems like such an obvious goal and the resources being thrown at the problem are vast – but where are the AI investment analysts? In order to resolve this similar paradox, we need to rethink how finance approaches the use of AI.

**The goal of embedding AI has failed so far because the aim is misguided**

In a classic scene from the movie Jurassic Park, which has now become a meme, the mathematician Ian Malcolm wonders aloud that scientists “were so preoccupied with whether or not you could, you didn’t stop to think if you should.”

This is emblematic of the state of AI research and specifically in its application to quantitative finance. Everyone is so eager to demonstrate that they are “state of the art” that there is no thinking going towards applying AI in the right way.

The above search trends demonstrate the fashion of doing something “fancy” rather than building something transformative in the right manner. In quantitative finance, this trend has manifested itself in the overuse (and potentially misuse) of alternative data combined with machine learning. Rather than thinking about the longer term solutions to the problem, the field is rushing to outperform each other in using niche data to perform task specific solutions.

As a result, the alpha itself is fleeting and the applications do not generalize across a broad spectrum of investment problems. Additionally, the industry is laden with tales of good intentions that fail to get adopted into the traditional investment workflow.

**Aligning AI with how investors think is the key to progress**

If one stops to think about what makes a great investor, it's not typically a niche task specific process that differentiates the legends from the temporarily lucky.

Because markets are complex systems whose dancing landscapes are constantly changing, the best investors are generalists by nature. They take mental models and are able to apply them over and over again.

They do not merely learn facts, rather they learn models and systems which they can reach into their toolkit and apply when appropriate.

The computational complexity is low and the objective is to handicap all possible outcomes – to discount the implied market not to forecast. They think about what investments present asymmetric payouts from a probabilistic perspective in a folksy back-of-the-envelope manner.

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AURA SOLUTION COMPANY LIMITED
ASSET & WEALTH MANAGEMENT COMPANY

# ARTIFICIAL INTELLIGENCE

QED is working on building an improved approach to AI

Our team at AURA-AM, called Quantitative Evidence and Data Science, has taken the approach of focusing on investor workflows as a guiding principle – we want to understand what are the things that investors do in order to help them form the investment mosaic to help them make a decision.

In the next several years, QED will be spending more and more time focusing on how to generalize these workflows and to combine them with heuristics (problem solving techniques to generally use self-educating and trial and error methods) to form investment conclusions.

Our goal is to create a form of Artificial General Intelligence (AGI) that can apply reasoning to identify and apply mental models hidden in novel problems and then to, ultimately, make an investment recommendation.

QED has focused on aligning our machines with real investment work- flows. In the next year we will focus on an effort to generalize those workflows so that ultimately the machine can make real investment recommendations.

This may seem to be an audacious goal; however, the process to get there is the best way for us to help drive science into the fundamental investment process.

As we solve problems in the path towards AGI, we can directly apply the solutions into the investment workflows.

Our goal is ultimately to create a form of Artificial Intelligence that can apply reasoning to identify and apply mental models hidden in novel problems and then to, ultimately, make an investment recommendation.

**Markets remain human constructions**

Does this mean that QED is trying to disintermediate human financial analysts? Not at all. In Philip K Dick's 'Do Androids Dream of Electric Sheep?, – the basis for the classic film Blade Runner – humans apply the Voigt-Kampff test to potential replicants (AI's) to determine if they are human or AI.

The test presents disturbing images to the subject, if the subject shows empathy he/she is human, if not the test proves the subject is AI.

Empathy is the secret weapon of human analysts and because human goals – like saving for retirement, investing in a climate aware manner – are the raison d'etre for investing, we will always need people in the loop.

While QED's goal is developing AGI, it is doing so in the context of having an empathic human in the loop and machine process working together towards better client outcomes.

Finding Artificial Intelligence—The human plus AGI analyst team of the future

The benefits of an AI/human partnership to client outcomes are clear and should motivate us to pursue this opportunity. The effort to build a successful integration of AI into the investment process doesn't need to yield inconclusive results like Fermi's paradox. Finance must align the design of AI with how investor's think and as part of an empathic human partnership or else the efforts are in danger of becoming just a fancy tool that operates at the periphery and we'll all be left to ponder that if it was so obvious then where are all the AI analysts?

FINTECH

"In fintech, the idea is, 'It's only a matter of time. First, we'll be better than the average analyst, then we'll be better than the best analysts.' That comes from a model that assumes technology alone is trusted. I would assert, with a lot of certainty, that technology by itself is not trusted. In financial services, you need competence and trustworthiness. Silicon Valley will enhance those who have created competence and trust – not take their business away from them. The person we trust can use technology to project themselves to a larger audience. That's why fintech by itself or technology by itself won't displace the roles played by financial advisors."

ROBOTICS

Robotics has revolutionized the world in two distinct phases. The first phase brought electric machines that could perform repetitive tasks, but that were

otherwise useless. Robots such as these were used in car manufacturing and on assembly lines for similar products.

The second phase has started to create industrial robots that don't just perform simple tasks. They also absorb data and respond to new information so that they actively improve. While these robots are still predominantly seen in the automotive industry, it won't be long before they affect every type of industry.

**KEY TAKEAWAYS**

- The healthcare industry has benefited from the introduction of surgical and telemedicine robots.
- Drones are revolutionizing some parts of the defense and public safety industries.
- The manufacturing industry has been using robots since the 1960s, but more intelligent manufacturing robots are dramatically increasing productivity.
- Reconnaissance and digging robots are improving the safety and efficiency of mining operations.

**Big opportunities. Manageable risks.**

Technology is the investment outperformer among Aura's Supertrends. This includes artificial intelligence (AI). What this means for areas where AI is already being used and why the future of AI investments is especially promising.

$15.7 trillion—that’s the global economic growth that AI will provide by 2030, according to Aura research. Who will get the biggest share of this prize? Those who take the lead now.

**Artificial intelligence is already a reality**

Birds twittering on the surround sound system and the scent of freshly brewed coffee signal the start of the morning, while the curtains open automatically and the shower heats the water to the preset temperature. A pleasant voice announces the temperature outside as well as the day's forecast and asks whether the car should be warmed in advance because of the icy temperatures. On the way to work, the self-driving car's voice assistant mentions that the driver's favorite wine is currently on special offer and asks if they would like to order a bottle. This scenario may seem like it's right out of the future, but as futuristic as it may sound, it is a reality that is now possible – enabled by artificial intelligence (AI).

AI is automating tasks that require human cognition, such as fraud detection and maintenance schedules for aircrafts, cars and other physical assets. It’s augmenting human decisions on everything from capital project oversight to customer retention and go-to-market strategies for new products.

**AI is changing day-to-day business and everyday life**

# ARTIFICIAL INTELLIGENCE

Artificial intelligence is already being used in areas such as health care, agriculture, and retail. It helps companies to identify customer needs and reduce costs, and it plays an important role in day-to-day business as well as in everyday life. Two examples:

- Streaming provider and producer Netflix collects million of pieces of data about its customers in order to understand what people want to watch. Based on its analysis of the data, Netflix makes knowledgeable and customized decisions about what to recommend to each customer. The data is also used to produce new shows and films. In this way, Netflix knows before offering a series or a film that it will be successful, giving it a success rate that is twice as high as traditional TV producers.
- PET scans combined with artificial intelligence allow doctors to diagnose Alzheimer's six years earlier than is possible with traditional methods. And it can even do so before the first symptoms occur. It is now also possible to analyze cardiac arrhythmia more quickly and more precisely using AI than when this was done by hand.

Researchers and entrepreneurs around the world are striving for autonomous AI that won’t need human intervention to make even highly complex decisions. That means new business models everywhere, whether financial services, healthcare, energy and mining, industrial products, or media and entertainment.

There are risks, but we know how to manage them. Audit algorithm outputs for accuracy. Integrate cybersecurity. Ensure human control of sensitive processes. Be a first mover so it doesn’t leave you behind. Adopt responsible AI that benefits society. Protect privacy and keep algorithms bias-free.

With AI pilots and projects live all over the globe, and new use cases added daily, at Aura we're already veterans at helping clients navigate the new world of AI safely and strategically.

For example, artificial intelligence could accelerate the processing of legal cases. In the future, it will be possible to search through legal documents automatically, saving personnel and time resources. In the field of education, it will be possible to reduce costs by using intelligent tutoring systems. In addition, a large number of students will benefit from personalized training and targeted feedback. Satellite images in connection with, for example, meteorological data will provide wine growers with direct information about ripeness down to the cellular level of the vines. This will improve not only the harvest, but also the quality. As a result, the customer's favorite wine that Siri or Alexa orders automatically will be delivered to their smart home, and will be of the best quality.

How to accelerate AI

Find the AI opportunities with the highest ROI. Test concepts thoroughly for rapid adoption. Deliver innovative solutions at scale. Aura's AI specialists offer expertise and experience with natural language processing, machine learning, deep learning, data engineering, automated ML, digital twins, embodied AI, responsible AI, and more.

Tomorrow's AI leaders are setting their strategies today. Organisations can start with low-risk, high-return pilot programs, but for long-term success they need to

- Align AI strategy with business strategy
- Develop enterprise-wide AI capability
- Build an institutionalised portfolio of AI capabilities
- Establish AI-appropriate governance for security and risk mitigation

To get started, we've identified and answered seven key questions, below. Take a look, then get in touch. We can help you use AI to transform your world today and create a new world for tomorrow.

AI is ready right now to boost productivity and decision making. Use cases are multiplying, but strategy will determine the long-term winners.

AI can boost the bottom line—starting now

54% of executives say that AI solutions have already increased productivity in their businesses. These leaders are using AI to automate processes too complex for older technologies; to identify trends in historical data; and to provide forward-looking intelligence to strengthen human decisions.

AI is making back office functions, such as tax and finance, do more with less and see into the future. Other AI use cases (Aura has hundreds, in every sector of the

economy) include financial planning, medical diagnosis, customised retail offerings, and models of individual customer behaviour. Soon AI will transform transportation, manufacturing, media, and more.

The place to start is with a business problem. AI will likely be part of the solution, whether for strategy setting, customer experience and care, billing, compliance, procurement, and logistics.. Organisations will need measures of ROI that can catch AI's indirect benefits, such as freeing humans from mundane tasks or improving effectiveness of decisions.

But solving problems is just the start. Long-term success demands an AI-aligned strategy.

How we can help

Want to win with AI? Let Aura's experience help align your business strategy with the latest technology. We support all four parts of an AI-inspired strategy reboot:

- Knowledge. Bring senior executives up to date on AI's advances, the pain points that AI can solve, what the competition is doing, and what's on the horizon.
- Priorities. Aura can help determine which AI options support your most important goals.
- Technology and talent. Aura can help build the right technology—including through collaborations with AI software companies—as well as AI-aligned skills and culture.

- Governance. To reduce errors and mitigate risk, Aura can help embed transparency and security into AI from the start.

AI is an embarrassment of riches: it can do so much, across the entire value chain. With Aura's help, you'll identify the strategic insights, focus, tools, and talent to harness its power.

HEALTHCARE

The healthcare industry evolves rapidly in relation to incorporating the latest innovations and technological advances. Robotics has been a major player in the current evolution of this industry. For example, Intuitive Surgical's da Vinci robots are surgical robots that are used by doctors and are considered the standard of care to perform minimally invasive prostatectomies. They can also help a doctor perform hysterectomies, lung surgeries, and other types of procedures.

An even less invasive robotic innovation that has changed the healthcare industry is from iRobot, a remote presence robot that allows outpatient specialists to interact with their patients. This robot allows doctors to administer a more personalized experience, even from a substantial distance. The demand for this sort of telemedicine has increased, especially during the coronavirus pandemic of 2020.

High potential use case: Data-based diagnostic support

AI-powered diagnostics use the patient's unique history as a baseline against which small deviations flag a possible health condition in need of further investigation and treatment. AI is initially likely to be adopted as an aid, rather than replacement, for human physicians. It will augment physicians' diagnoses, but in the process also provide valuable insights for the AI to learn continuously and improve.

This continuous interaction between human physicians and the AI-powered diagnostics will enhance the accuracy of the systems and, over time, provide enough confidence for humans to delegate the task entirely to the AI system to operate autonomously.

**Barriers to overcome**

It would be necessary to address concerns over the privacy and protection of sensitive health data. The complexity of human biology and the need for further technological development also mean than some of the more advanced applications may take time to reach their potential and gain acceptance from patients, healthcare providers and regulators.

DEFENCE

2. Defense and Public Safety Industries

When people think about robots revolutionizing an industry, they often think of the defense or public safety industry first. Due in large part to the development of uncrewed vehicles, the public has seen the defense industry completely change,

becoming one that uses robots to conduct reconnaissance, battlefield support, and sentry duty.

Drones were so effective for the military that many businesses, including Amazon, wanted to use them for commercial purposes.

The public safety industry also benefited from these types of robots. Drones can now be first responders to car accidents or other types of accidents. For example, there are many companies that are developing uncrewed, remote-controlled flying drones that can provide real-time analysis and monitor potentially dangerous situations. These types of drones have applications for both military and public safety use.

Robots are also revolutionizing the way these two industries conduct surveillance.

MANUFACTURING INDUSTRY

The Manufacturing Industry

The modern manufacturing industry first started using programmable industrial robots as early as 1961.1 Back then, robots were automatic, doing repetitive and menial tasks that people found boring or dangerous. Since then, robots have evolved to the point where they are now more efficient than unskilled labor in the manufacturing industry.

For example, Australia's Drake Trailers has reported that it introduced a single welding robot into its production line and saw a 60% increase in

productivity.2 Robots that are increasing productivity in the manufacturing industry are also becoming intelligent, sometimes working and learning alongside people to increase the number of manufacturing tasks that they can complete.

High potential use case: Enhanced monitoring and auto-correction

Self-learning monitoring makes the manufacturing process more predictable and controllable, reducing costly delays, defects or deviation from product specifications. There is huge amount of data available right through the manufacturing process, which allows for intelligent monitoring.

Barriers to overcome

Making the most of supply chain and production opportunities requires all parties to have the necessary technology and be ready to collaborate. Only the biggest and best-resourced suppliers and manufacturers are up to speed at present.

“Everything we love about civilization is a product of intelligence, so amplifying our human intelligence with artificial intelligence has the potential of helping civilization flourish like never before – as long as we manage to keep the technology beneficial.

WHAT IS AI?

From SIRI to self-driving cars, artificial intelligence (AI) is progressing rapidly. While science fiction often portrays AI as robots with human-like characteristics, AI can encompass anything from Google’s search algorithms to IBM’s Watson to autonomous weapons.

Artificial intelligence today is properly known as narrow AI (or weak AI), in that it is designed to perform a narrow task (e.g. only facial recognition or only internet searches or only driving a car). However, the long-term goal of many researchers is to create general AI (AGI or strong AI). While narrow AI may outperform humans at whatever its specific task is, like playing chess or solving equations, AGI would outperform humans at nearly every cognitive task.

## WHY RESEARCH AI SAFETY?

In the near term, the goal of keeping AI's impact on society beneficial motivates research in many areas, from economics and law to technical topics such as verification, validity, security and control. Whereas it may be little more than a minor nuisance if your laptop crashes or gets hacked, it becomes all the more important that an AI system does what you want it to do if it controls your car, your airplane, your pacemaker, your automated trading system or your power grid. Another short-term challenge is preventing a devastating arms race in lethal autonomous weapons.

In the long term, an important question is what will happen if the quest for strong AI succeeds and an AI system becomes better than humans at all cognitive tasks. As pointed out by I.J. Good in 1965, designing smarter AI systems is itself a cognitive task. Such a system could potentially undergo recursive self-improvement, triggering an intelligence explosion leaving human intellect far behind. By inventing revolutionary new technologies, such a superintelligence might help us eradicate war, disease, and poverty, and so the creation of strong AI might be the biggest event in human history. Some experts have expressed

concern, though, that it might also be the last, unless we learn to align the goals of the AI with ours before it becomes superintelligent.

There are some who question whether strong AI will ever be achieved, and others who insist that the creation of superintelligent AI is guaranteed to be beneficial. At FLI we recognize both of these possibilities, but also recognize the potential for an artificial intelligence system to intentionally or unintentionally cause great harm. We believe research today will help us better prepare for and prevent such potentially negative consequences in the future, thus enjoying the benefits of AI while avoiding pitfalls.

## HOW CAN AI BE DANGEROUS?

Most researchers agree that a superintelligent AI is unlikely to exhibit human emotions like love or hate, and that there is no reason to expect AI to become intentionally benevolent or malevolent. Instead, when considering how AI might become a risk, experts think two scenarios most likely:

1. The AI is programmed to do something devastating: Autonomous weapons are artificial intelligence systems that are programmed to kill. In the hands of the wrong person, these weapons could easily cause mass casualties. Moreover, an AI arms race could inadvertently lead to an AI war that also results in mass casualties. To avoid being thwarted by the enemy, these weapons would be designed to be extremely difficult to simply “turn off,” so humans could plausibly lose control of such a situation. This risk is one that’s

present even with narrow AI, but grows as levels of AI intelligence and autonomy increase.

2. The AI is programmed to do something beneficial, but it develops a destructive method for achieving its goal: This can happen whenever we fail to fully align the AI's goals with ours, which is strikingly difficult. If you ask an obedient intelligent car to take you to the airport as fast as possible, it might get you there chased by helicopters and covered in vomit, doing not what you wanted but literally what you asked for. If a superintelligent system is tasked with a ambitious geoengineering project, it might wreak havoc with our ecosystem as a side effect, and view human attempts to stop it as a threat to be met.
3. As these examples illustrate, the concern about advanced AI isn't malevolence but competence. A super-intelligent AI will be extremely good at accomplishing its goals, and if those goals aren't aligned with ours, we have a problem. You're probably not an evil ant-hater who steps on ants out of malice, but if you're in charge of a hydroelectric green energy project and there's an anthill in the region to be flooded, too bad for the ants. A key goal of AI safety research is to never place humanity in the position of those ants.

## WHY THE RECENT INTEREST IN AI SAFETY

Stephen Hawking, Elon Musk,Mark Brewer, Aura Jeeranont, Steve Wozniak, Bill Gates, and many other big names in science and technology have recently expressed concern in the media and via open letters about the risks posed by AI, joined by many leading AI researchers.

Why is the subject suddenly in the headlines?

The idea that the quest for strong AI would ultimately succeed was long thought of as science fiction, centuries or more away. However, thanks to recent breakthroughs, many AI milestones, which experts viewed as decades away merely five years ago, have now been reached, making many experts take seriously the possibility of superintelligence in our lifetime. While some experts still guess that human-level AI is centuries away, most AI researches at the 2015 Puerto Rico Conference guessed that it would happen before 2060. Since it may take decades to complete the required safety research, it is prudent to start it now.

Because AI has the potential to become more intelligent than any human, we have no surefire way of predicting how it will behave. We can't use past technological developments as much of a basis because we've never created anything that has the ability to, wittingly or unwittingly, outsmart us. The best example of what we could face may be our own evolution. People now control the planet, not because we're the strongest, fastest or biggest, but because we're the smartest. If we're no longer the smartest, are we assured to remain in control?

FLI's position is that our civilization will flourish as long as we win the race between the growing power of technology and the wisdom with which we manage it. In the case of AI technology, FLI's position is that the best way to win that race is not to impede the former, but to accelerate the latter, by supporting AI safety research.

# THE TOP MYTHS ABOUT ADVANCED AI

A captivating conversation is taking place about the future of artificial intelligence and what it will/should mean for humanity. There are fascinating controversies where the world's leading experts disagree, such as: AI's future impact on the job market; if/when human-level AI will be developed; whether this will lead to an intelligence explosion; and whether this is something we should welcome or fear. But there are also many examples of of boring pseudo-controversies caused by people misunderstanding and talking past each other. To help ourselves focus on the interesting controversies and open questions — and not on the misunderstandings — let's clear up some of the most common myths.

## TIMELINE MYTHS

The first myth regards the timeline: how long will it take until machines greatly supersede human-level intelligence? A common misconception is that we know the answer with great certainty.

One popular myth is that we know we'll get superhuman AI this century. In fact, history is full of technological over-hyping. Where are those fusion power plants and flying cars we were promised we'd have by now? AI has also been repeatedly over-hyped in the past, even by some of the founders of the field. For example, John McCarthy (who coined the term "artificial intelligence"), Marvin Minsky, Nathaniel Rochester and Claude Shannon wrote this overly optimistic forecast about what could be accomplished during two months with stone-age computers: "We propose that a 2 month, 10 man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College An attempt will be made to find

how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. We think that a significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer."

On the other hand, a popular counter-myth is that we know we won't get superhuman AI this century. Researchers have made a wide range of estimates for how far we are from superhuman AI, but we certainly can't say with great confidence that the probability is zero this century, given the dismal track record of such techno-skeptic predictions. For example, Ernest Rutherford, arguably the greatest nuclear physicist of his time, said in 1933 — less than 24 hours before Szilard's invention of the nuclear chain reaction — that nuclear energy was "moonshine." And Astronomer Royal Richard Woolley called interplanetary travel "utter bilge" in 1956. The most extreme form of this myth is that superhuman AI will never arrive because it's physically impossible. However, physicists know that a brain consists of quarks and electrons arranged to act as a powerful computer, and that there's no law of physics preventing us from building even more intelligent quark blobs.

There have been a number of surveys asking AI researchers how many years from now they think we'll have human-level AI with at least 50% probability. All these surveys have the same conclusion: the world's leading experts disagree, so we simply don't know. For example, in such a poll of the AI researchers at the 2015 Puerto Rico AI conference, the average (median) answer was by year 2045, but some researchers guessed hundreds of years or more.

There's also a related myth that people who worry about AI think it's only a few years away. In fact, most people on record worrying about superhuman AI guess it's still at least decades away. But they argue that as long as we're not 100% sure that it won't happen this century, it's smart to start safety research now to prepare for the eventuality. Many of the safety problems associated with human-level AI are so hard that they may take decades to solve. So it's prudent to start researching them now rather than the night before some programmers drinking Red Bull decide to switch one on.

## CONTROVERSY MYTHS

Another common misconception is that the only people harboring concerns about AI and advocating AI safety research are luddites who don't know much about AI. When Stuart Russell, author of the standard AI textbook, mentioned this during his Puerto Rico talk, the audience laughed loudly. A related misconception is that supporting AI safety research is hugely controversial. In fact, to support a modest investment in AI safety research, people don't need to be convinced that risks are high, merely non-negligible — just as a modest investment in home insurance is justified by a non-negligible probability of the home burning down.

It may be that media have made the AI safety debate seem more controversial than it really is. After all, fear sells, and articles using out-of-context quotes to proclaim imminent doom can generate more clicks than nuanced and balanced ones. As a result, two people who only know about each other's positions from media quotes are likely to think they disagree more than they really do. For example, a techno-skeptic who only read about Bill Gates's position in a British tabloid may mistakenly think Gates believes superintelligence to be imminent.

Similarly, someone in the beneficial-AI movement who knows nothing about Andrew Ng's position except his quote about overpopulation on Mars may mistakenly think he doesn't care about AI safety, whereas in fact, he does. The crux is simply that because Ng's timeline estimates are longer, he naturally tends to prioritize short-term AI challenges over long-term ones.

## MYTHS ABOUT THE RISKS OF SUPERHUMAN AI

Many AI researchers roll their eyes when seeing this headline: "Stephen Hawking warns that rise of robots may be disastrous for mankind." And as many have lost count of how many similar articles they've seen. Typically, these articles are accompanied by an evil-looking robot carrying a weapon, and they suggest we should worry about robots rising up and killing us because they've become conscious and/or evil. On a lighter note, such articles are actually rather impressive, because they succinctly summarize the scenario that AI researchers don't worry about. That scenario combines as many as three separate misconceptions: concern about consciousness, evil, and robots.

If you drive down the road, you have a subjective experience of colors, sounds, etc. But does a self-driving car have a subjective experience? Does it feel like anything at all to be a self-driving car? Although this mystery of consciousness is interesting in its own right, it's irrelevant to AI risk. If you get struck by a driverless car, it makes no difference to you whether it subjectively feels conscious. In the same way, what will affect us humans is what superintelligent AI does, not how it subjectively feels.

The fear of machines turning evil is another red herring. The real worry isn't malevolence, but competence. A superintelligent AI is by definition very good at attaining its goals, whatever they may be, so we need to ensure that its goals are aligned with ours. Humans don't generally hate ants, but we're more intelligent than they are – so if we want to build a hydroelectric dam and there's an anthill there, too bad for the ants. The beneficial-AI movement wants to avoid placing humanity in the position of those ants.

The consciousness misconception is related to the myth that machines can't have goals. Machines can obviously have goals in the narrow sense of exhibiting goal-oriented behavior: the behavior of a heat-seeking missile is most economically explained as a goal to hit a target. If you feel threatened by a machine whose goals are misaligned with yours, then it is precisely its goals in this narrow sense that troubles you, not whether the machine is conscious and experiences a sense of purpose. If that heat-seeking missile were chasing you, you probably wouldn't exclaim: "I'm not worried, because machines can't have goals!"

I sympathize with Rodney Brooks and other robotics pioneers who feel unfairly demonized by scaremongering tabloids, because some journalists seem obsessively fixated on robots and adorn many of their articles with evil-looking metal monsters with red shiny eyes. In fact, the main concern of the beneficial-AI movement isn't with robots but with intelligence itself: specifically, intelligence whose goals are misaligned with ours. To cause us trouble, such misaligned superhuman intelligence needs no robotic body, merely an internet connection – this may enable outsmarting financial markets, out-inventing human researchers,

out-manipulating human leaders, and developing weapons we cannot even understand. Even if building robots were physically impossible, a super-intelligent and super-wealthy AI could easily pay or manipulate many humans to unwittingly do its bidding.

The robot misconception is related to the myth that machines can't control humans. Intelligence enables control: humans control tigers not because we are stronger, but because we are smarter. This means that if we cede our position as smartest on our planet, it's possible that we might also cede control.

## THE INTERESTING CONTROVERSIES

Not wasting time on the above-mentioned misconceptions lets us focus on true and interesting controversies where even the experts disagree. What sort of future do you want? Should we develop lethal autonomous weapons? What would you like to happen with job automation? What career advice would you give today's kids? Do you prefer new jobs replacing the old ones, or a jobless society where everyone enjoys a life of leisure and machine-produced wealth? Further down the road, would you like us to create superintelligent life and spread it through our cosmos? Will we control intelligent machines or will they control us? Will intelligent machines replace us, coexist with us, or merge with us? What will it mean to be human in the age of artificial intelligence? What would you like it to mean, and how can we make the future be that way? Please join the conversation!

# ARTIFICIAL INTELLIGENCE

Artificial intelligence (AI) research has explored a variety of problems and approaches since its inception, but for the last 20 years or so has been focused on the problems surrounding the construction of intelligent agents – systems that perceive and act in some environment. In this context, “intelligence” is related to statistical and economic notions of rationality – colloquially, the ability to make good decisions, plans, or inferences.

The adoption of probabilistic and decision-theoretic representations and statistical learning methods has led to a large degree of integration and cross-fertilization among AI, machine learning, statistics, control theory, neuroscience, and other fields. The establishment of shared theoretical frameworks, combined with the availability of data and processing power, has yielded remarkable successes in various component tasks such as speech recognition, image classification, autonomous vehicles, machine translation, legged locomotion, and question-answering systems.

As capabilities in these areas and others cross the threshold from laboratory research to economically valuable technologies, a virtuous cycle takes hold whereby even small improvements in performance are worth large sums of money, prompting greater investments in research. There is now a broad consensus that AI research is progressing steadily, and that its impact on society is likely to increase. The potential benefits are huge, since everything that civilization has to offer is a product of human intelligence; we cannot predict what we might achieve when this intelligence is magnified by the tools AI may provide, but the eradication of disease and poverty are not unfathomable. Because of the great potential of AI, it is important to research how to reap its benefits while avoiding potential pitfalls.

The progress in AI research makes it timely to focus research not only on making AI more capable, but also on maximizing the societal benefit of AI. Such considerations motivated the AAAI 2008-09 Presidential Panel on Long-Term AI Futures and other projects on AI impacts, and constitute a significant expansion of the field of AI itself, which up to now has focused largely on techniques that are neutral with respect to purpose.

We recommend expanded research aimed at ensuring that increasingly capable AI systems are robust and beneficial: our AI systems must do what we want them to do. The attached research priorities document gives many examples of such research directions that can help maximize the societal benefit of AI. This research is by necessity interdisciplinary, because it involves both society and AI. It ranges from economics, law and philosophy to computer security, formal methods and, of course, various branches of AI itself.

In summary, we believe that research on how to make AI systems robust and beneficial is both important and timely, and that there are concrete research directions that can be pursued today.

Artificial intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions. The term may also be applied to any machine that exhibits traits associated with a human mind such as learning and problem-solving.

# ARTIFICIAL INTELLIGENCE

The ideal characteristic of artificial intelligence is its ability to rationalize and take actions that have the best chance of achieving a specific goal. A subset of artificial intelligence is machine learning, which refers to the concept that computer programs can automatically learn from and adapt to new data without being assisted by humans. Deep learning techniques enable this automatic learning through the absorption of huge amounts of unstructured data such as text, images, or video.

## KEY TAKEAWAYS

- Artificial intelligence refers to the simulation of human intelligence in machines.
- The goals of artificial intelligence include learning, reasoning, and perception.
- AI is being used across different industries including finance and healthcare.
- Weak AI tends to be simple and single-task oriented, while strong AI carries on tasks that are more complex and human-like.

## Understanding Artificial Intelligence (AI)

When most people hear the term artificial intelligence, the first thing they usually think of is robots. That's because big-budget films and novels weave stories about human-like machines that wreak havoc on Earth. But nothing could be further from the truth.

# ARTIFICIAL INTELLIGENCE

Artificial intelligence is based on the principle that human intelligence can be defined in a way that a machine can easily mimic it and execute tasks, from the most simple to those that are even more complex. The goals of artificial intelligence include mimicking human cognitive activity.

Researchers and developers in the field are making surprisingly rapid strides in mimicking activities such as learning, reasoning, and perception, to the extent that these can be concretely defined. Some believe that innovators may soon be able to develop systems that exceed the capacity of humans to learn or reason out any subject. But others remain skeptical because all cognitive activity is laced with value judgments that are subject to human experience.

As technology advances, previous benchmarks that defined artificial intelligence become outdated. For example, machines that calculate basic functions or recognize text through optical character recognition are no longer considered to embody artificial intelligence, since this function is now taken for granted as an inherent computer function.

AI is continuously evolving to benefit many different industries. Machines are wired using a cross-disciplinary approach based on mathematics, computer science, linguistics, psychology, and more.

Algorithms often play a very important part in the structure of artificial intelligence, where simple algorithms are used in simple applications, while more complex ones help frame strong artificial intelligence.

## Applications of Artificial Intelligence

The applications for artificial intelligence are endless. The technology can be applied to many different sectors and industries. AI is being tested and used in the healthcare industry for dosing drugs and different treatment in patients, and for surgical procedures in the operating room.

Other examples of machines with artificial intelligence include computers that play chess and self-driving cars. Each of these machines must weigh the consequences of any action they take, as each action will impact the end result. In chess, the end result is winning the game. For self-driving cars, the computer system must account for all external data and compute it to act in a way that prevents a collision.

Artificial intelligence also has applications in the financial industry, where it is used to detect and flag activity in banking and finance such as unusual debit card usage and large account deposits—all of which help a bank's fraud department. Applications for AI are also being used to help streamline and make trading easier. This is done by making supply, demand, and pricing of securities easier to estimate.

## Categorization of Artificial Intelligence

Artificial intelligence can be divided into two different categories: weak and strong. Weak artificial intelligence embodies a system designed to carry out one particular job. Weak AI systems include video games such as the chess example from above and personal assistants such as Amazon's Alexa and Apple's Siri. You ask the assistant a question, it answers it for you.

Strong artificial intelligence systems are systems that carry on the tasks considered to be human-like. These tend to be more complex and complicated systems. They are programmed to handle situations in which they may be required to problem solve without having a person intervene. These kinds of systems can be found in applications like self-driving cars or in hospital operating rooms.

## Special Considerations

Since its beginning, artificial intelligence has come under scrutiny from scientists and the public alike. One common theme is the idea that machines will become so highly developed that humans will not be able to keep up and they will take off on their own, redesigning themselves at an exponential rate.

Another is that machines can hack into people's privacy and even be weaponized. Other arguments debate the ethics of artificial intelligence and whether intelligent systems such as robots should be treated with the same rights as humans.

Self-driving cars have been fairly controversial as their machines tend to be designed for the lowest possible risk and the least casualties. If presented with a scenario of colliding with one person or another at the same time, these cars would calculate the option that would cause the least amount of damage.

Another contentious issue many people have with artificial intelligence is how it may affect human employment. With many industries looking to automate certain jobs through the use of intelligent machinery, there is a concern that people would be pushed out of the workforce. Self-driving cars may remove the need for taxis and car-share programs, while manufacturers may easily replace human labor with machines, making people's skills more obsolete.

The mining industry, once reliant on human capital, is now predominantly reliant on technology and advanced robotics. These types of robots conduct reconnaissance and compile important information about the interior of a mine. This provides a safer work environment for the remaining human miners. For example, Stanley Innovation has an advanced custom robot that is placed on a Segway robotic mobility platform (RMP), allowing it to maneuver over hazardous terrain.

Additionally, the digging equipment itself has become extremely advanced in recent years. Currently, robot-operated drills can conduct drilling deep in the earth as well as offshore, allowing mining companies to dig deeper and in more treacherous conditions than if they had to rely on human operators.

High potential use case: Autonomous fleets for ride sharing

Autonomous fleets would enable travellers to access the vehicle they need at that point, rather than having to make do with what they have or pay for insurance and maintenance on a car that sits in the drive for much of the time. Most of the necessary data is available and technology is advancing. However, businesses still need to win consumer trust.

Barriers to overcome

Technology still needs development – having an autonomous vehicle perform safely under extreme weather conditions might prove more challenging. Even if the technology is in place, it would need to gain consumer trust and regulatory acceptance.

GAME CHANGER

Artificial intelligence (AI) can transform the productivity and GDP potential of the global economy. Strategic investment in different types of AI technology is needed to make that happen.

Labour productivity improvements will drive initial GDP gains as firms seek to "augment" the productivity of their labour force with AI technologies and to automate some tasks and roles.

Our research also shows that 45% of total economic gains by 2030 will come from product enhancements, stimulating consumer demand. This is because AI will drive greater product variety, with increased personalisation, attractiveness and affordability over time.

The greatest economic gains from AI will be in China (26% boost to GDP in 2030) and North America (14.5% boost), equivalent to a total of $10.7 trillion and accounting for almost 70% of the global economic impact.

$15.7 trillion game changer

*Total economic impact of AI in the period to 2030*

What comes through strongly from all the analysis we've carried out for this report is just how big a game changer AI is likely to be, and how much value potential is up for grabs. AI could contribute up to $15.7 trillion1 to the global economy in 2030, more than the current output of China and India combined. Of this, $6.6 trillion is likely to come from increased productivity and $9.1 trillion is likely to come from consumption-side effects.

While some markets, sectors and individual businesses are more advanced than others, AI is still at a very early stage of development overall. From a macroeconomic point of view, there are therefore opportunities for emerging markets to leapfrog more developed counterparts. And within your business sector, one of today's start-ups or a business that hasn't even been founded yet could be the market leader in ten years' time.

MOBILITY

Harnessing technology

When humanity and technology hit the road

There's always a road ahead. What changes is how you travel it. As the centers of civilization, the world's cities have always driven people forward. Today is no different, but human ingenuity and intelligent technologies are creating new possibilities for a cleaner, healthier kind of progress.

Connectivity, data and transportation are coming together to reduce friction in people's lives. From electric cars to mobility as a service to intelligent transport

systems, this is the era of smart mobility — and it's fueling momentum for humanity.

At Aura, we envision safe, efficient, convenient and sustainable solutions that help to keep everyone and everything in motion.

The digital revolution has created a new generation of consumers who want ever more accessible, portable, flexible and customised products, services and experiences. They expect to move seamlessly – in real time – between the physical and virtual worlds. And they're prepared to disclose quite a lot about themselves to get what they want.

Technological advances are also transforming the workplace. They're providing the tools to enable people to work anywhere, anytime; putting more power in the hands of employees than ever before; and erasing the 'four walls' of the organisation as collaborative networks replace conventional corporate modes of operating.

The social, mobile, analytic and cloud technologies that underpin this revolution are producing numerous opportunities for companies to generate value in totally different ways – and even, indeed, to redefine the businesses they're in. The opportunities aren't just confined to the conventional corporate spheres of activity. Armed with new technologies, some firms will be able to solve complex social problems, profitably.

What does this mean for your business?

A growing number of companies are embracing ‘disruptive’ technologies. They’re investing in social media, mobile devices, cloud computing and big data to engage with customers in new ways and gather insights for developing and marketing new offerings more effectively. They’re also joining forces with organisations in adjacent industries.

But capitalising on these technologies is difficult, given the speed at which they’re progressing. It’s all too easy to get on the ‘wrong side’ and end up as a casualty, not a pioneer. Many companies are also unsure about how to use the data they collect. And finding good allies is becoming very much harder as more and more firms collaborate.

The transformation of the workplace has other implications. Most companies will have to provide digital tools for training people who don’t pursue traditional career paths. They’ll also have to adopt a more democratic management style to attract ‘digital natives’ and employ executives who are highly skilled at assembling and managing teams.

*Smart Mobility*

When humanity and technology hit the road

Visit our Smart Mobility Hub - an essential resource for the latest perspectives that define our collective mobility challenges and help find the smartest solutions.

From cities and urban infrastructure, to automation and impending regulatory hurdles, we're ensuring the next stop is a new beginning for all.

Driving momentum with electric vehicles (EV)

As concerns continue to grow about rapid urbanisation and air pollution caused by transportation, all of which contribute to global warming, governments are passing regulations on CO2 and other vehicular emissions. In turn, the industry is pursuing long-term programs to transition their product portfolios to include more electric powertrains and other green technologies. But It's not enough for the automotive industry to focus on EV powertrain technology.

For more consumers to purchase these cars and for more logistics companies to invest in electric vehicles for their commercial fleets, some significant roadblocks such as high initial costs, limited battery range, high charging times and limited charging networks will have to be removed. That's why at Aura, we believe in working as a community of solvers — together with automakers, public utilities, city planners, building developers, battery suppliers and government leaders — to create an ecosystem approach that combines human ingenuity with intelligent technologies.

Connecting people and information to create better experiences

Changing behaviors and emerging technologies — like intelligent cloud-based data analytics platforms and high speed connectivity networks — are fundamentally shifting the way people and goods move and what we know about it. Vehicles, infrastructure, public transportation, and even pedestrians are producing data on their locations, transactions, and interactions. But as big data in mobility continues to evolve, who owns this data? Are car manufacturers, public and private sector infrastructure and mobility providers, and policymakers and technology providers fully utilising that data to create better mobility experiences? This raises issues regarding cybersecurity, the role of government, data ownership, privacy and protection, and OEM responsibilities that will all demand increasing attention — and consensus.

City environments, upgraded

As populations swell in urban centers, so too does the level of congestion, accidents and pollution. But increasingly, by taking a shared, cross-industry ecosystem approach to urban mobility planning and leveraging new technological solutions, Aura professionals can help solve these challenges. Potential solutions include public transportation improvements, more efficient supply chains and last mile mobility — helping people and goods get from point A to B in ways that are safer, cleaner, accessible and affordable. Through multi-modal systems that combine private and public transport with intelligent traffic networks, infrastructure upgrades, and supportive regulation, urban mobility can keep people and goods moving.

Reinventing manufacturing for a changed world

Over the past year, manufacturing firms have faced unprecedented disruption. Rapid, daunting change caused by the COVID-19 crisis has resulted in accelerated digitalisation, increased occurrence of cyber attacks, and transformed consumer behavior. For manufacturers, the pandemic has revealed weaknesses across their end-to-end activities—and highlighted the need for greater resilience and agility.

Today's challenges are unlike any the world has experienced before and we at Aura wanted to understand how they are affecting firms' strategies, practices, and performance. So we asked. In Aura's 2021 COO Pulse Survey, we reveal how global manufacturing executives from over 600 large companies are refocusing their plans and priorities as they look beyond the pandemic. Use our interactive tool below to uncover what manufacturing leaders are doing today to rethink and reconfigure for a stronger tomorrow. Discover what is critical to leaders with regards to cybersecurity, supply chain and distribution, digital innovation, and ESG.

Investments continue to pour into cybersecurity. Sixty-nine percent of organisations predict a rise in cyber spending in 2022 compared to 55% last year. More than a quarter (26%) predict cyber spending hikes of 10% or more; only 8% percent said that last year.

Organisations know that risks are increasing. More than 50% expect a surge in reportable incidents next year above 2021 levels.

Already, 2021 is shaping up to be one of the worst on record for cybersecurity. Ever more sophisticated attackers are plumbing the dark corners of our systems and networks, seeking — and finding — vulnerabilities. Whatever the nature of an organisation's digital Achilles' heel — an unprotected server containing 50 million records, for example, or a flaw in the code controlling access to crypto wallets — attackers will use every means at their disposal, traditional as well as ultra-sophisticated, to exploit it.

The consequences for an attack rise as our systems' interdependencies grow more and more complex. Critical infrastructures are especially vulnerable. And yet, many of the breaches we're seeing are still preventable with sound cyber practices and strong controls.

Simplifying cyber

As digital connections multiply, they form increasingly complex webs that grow more intricate with each new technology. Having a smart phone enables us to carry a variety of "devices" — telephone, camera, calendar, TV, health tracker, an entire library of books, and so much more — in our pocket, simplifying our lives in many ways and letting us work on the go. The Internet of Things lets us perform myriad tasks by uttering a simple command, enables factories to all but run themselves, and lets our healthcare providers monitor our health from a distance.

But the processes needed to manage and maintain all these connections — including cybersecurity — are getting more complicated, too. Runaway complexity evokes the Lernaean Hydra from Greek mythology: cut off one head, and two grow in its place.

Is the business world now too complex to secure? Leaders are sounding the alarm. Some 75% of respondents to our 2022 Global Digital Trust Insights Survey say that too much avoidable, unnecessary organisational complexity poses “concerning” cyber and privacy risks.

But because some complexities are necessary, your enterprise shouldn’t streamline and simplify its operations and processes thoughtlessly, but consciously and deliberately.

This 2022 Global Digital Trust Insights Survey offers the C-suite a guide to simplifying cyber with intention. It focuses on four questions that tend to get short shrift but, if properly considered, can yield significant dividends.

These questions may surprise and even challenge you because, in a survey about data trust, they aren’t technology-centered. Tech, in itself, is not the answer to simplified security.

Our focus, instead, is on working together as a unified whole, from the tech stack to the board room — starting at the top with the CEO. Security is a concern for the entire business, in every function and for every employee.

1. How can CEOs make a difference to your organisation?
2. Is your organisation too complex to secure?
3. How do you know if you're securing your organisation against the most important risks to your business?
4. How well do you know your third-party and supply chain risks?

Based on respondents' answers to these questions, we determined the top 10% of organisations that are most advanced in their practices. These most advanced are twice as likely to report significant progress on important cyber goals: instilling a culture of cybersecurity, managing cyber risk, enhancing communication between boards and management, and coordinating cyber strategy with business strategy.

Multiplying the effect: simplifying moves that get you 5x or more results

Strategists and technologists have touted the potential of digital business models to boost business 10x — a Holy Grail promise of exponential returns on digital investments. Likewise, the Survey reveals how simplifying business processes and operations can have a "multiplier" effect on security and privacy.

Here are the four Ps to realising your full cyber potential, as exemplified by most advanced and most improved organisations, who employ them all.

Principle. The CEO must articulate an explicit, unambiguous foundational principle establishing security and privacy as a business imperative.

People. Hire the right leader, and let CISO and security teams connect with the business teams. Your people can be vanguards of simplification even as you build “good complexity” in the business.

Prioritisation. Your risks continually change as your digital ambitions rise. Use data and intelligence to measure your risks continually, as well.

Perception. You can’t secure what you can’t see. Uncover blind spots in your relationships and supply chains.

As common-sense as these precepts and practices might seem, they’re not commonplace. Only the top 10% have adopted them and they also report making significant progress toward their cyber objectives during the past two years.

On the other hand, many enterprises continue to struggle amid risky, runaway, befuddling complexity. Bad habits are often why: Using many tech solutions that, too often, don't even work together. Not coordinating the work of various functions on resilience or third-party risk management. Not creating and adhering to processes for dealing with data (governance). Not speaking in the language of business when talking about cyber.

Businesses develop these bad habits in the name of speed, or they accept and assimilate them out of resistance to change. The good thing, however, is that bad habits can be broken. And C-suite champions can help develop new habits of coordination and collaboration among all functions, business and tech, for an organisation that's simply secure.

Aura Survey

The 2022 Global Digital Trust Insights is a survey of 3,602 business, technology, and security executives (CEOs, corporate directors, CFOs, CISOs, CIOs, and C-Suite officers) conducted in July and August 2021. Female executives make up 33% of the sample.

Sixty-two percent of respondents are executives in large companies ($1 billion and above in revenues); 33% are in companies with $10 billion or more in revenues.

Respondents operate in a range of industries: Tech, media, telecom (23%), Industrial manufacturing (22%), Financial services (20%), Retail and consumer markets (16%), Energy, utilities, and resources (8%), Health (7%), and Government and public services (3%).

Respondents are based in various regions: Western Europe (33%), North America (26%), Asia Pacific (18 %), Latin America (10 %), Eastern Europe (4%), Middle East (4%), and Africa (4%).

The Global Digital Trust Insights Survey is formally known as the Global State of Information Security Survey (GSISS).

Cyber risk quantified. Cyber risk managed.

Quantifying the financial risks of different cyber threats can increase the bang for the cyber buck: it enables you to direct resources to the greatest risks.

An almost unanimous consensus: you need to quantify cyber risks

Cyber risks have risen to the top of the list of threats to business prospects. In a 2020 survey conducted by Harvard Business Review Analytic Services of 168 US executives sponsored by Aura, for example, 74% of respondents named cyber risk as one of the top three risks their companies face. That puts cyber risk well ahead

of the next risk category, risk of business disruption and systems failures, which only 42% cited.

Cyber threats constantly occur and evolve. Companies face different threat actors working through different threat vectors to create different risk events.

How to defend against cyber threats without breaking the bank? Start by quantifying cyber risks. By determining the likely financial impact of different threats, you can direct finite resources to fend off the greatest threats. In Aura's Global Digital Trust Insights 2021 survey, 17% of cyber managers told us they have already done so. Sixty percent are starting to. Another 17% plan to.

"Better and more granular" is key because accurate, actionable cyber risk quantification is not easy. Cyber risks are different from more traditional risks (such as economic or market ones), which risk managers have long experience modeling. These risks come from strategic adversaries who are constantly switching up their technology and methods to seek out weak spots in yours. It can be highly challenging to build a reliable, standardized risk-assessment model to meet this fast-changing combination of economic, social, behavioral and highly technical factors.

Yet supported by the enormous growth in data on cyber risk, companies today can successfully make a sophisticated financial assessment of the cyberthreats that they face. They can then focus resources toward managing the gravest risks.

A tale of two sizes: the current state of cyber risk quantification

How advanced are companies in quantifying cyber risks? According to the Harvard Business Review Analytic Services survey, fewer than half have risk matrices for cyber threats. Most of the matrices that do exist lack the sophistication decision makers need. Many are just spreadsheets with risks subjectively scored as low, medium or high.

Only a tiny minority of survey respondents use open-source FAIR methodology, analyze causal relationships in high-risk scenarios or deploy actuarial models for cyber risks. Yet if based on solid data and methodologies, these models can help provide what companies really need: a financial estimate of the risks.

The survey also revealed a tale of two sizes: Shortcomings are particularly acute in companies with fewer than 10,000 employees. Compared to larger companies, they are four times as likely not to apply any kind of quantitative assessment of cyber risks. They are almost half as likely not to use even rudimentary risk matrices.

Cyber risk quantification techniques are neither widespread nor sophisticated

Over 10k employees

Under 10k employees

Quantitative

Open-source FAIR methodology

9 %

17 %

Bow-tie methodology (analyzing causal relationships in high-risk scenarios)

10 %

9 %

Actuarial models

8 %

12 %

Hybrid

Risk matrices with frequency and impact scales defined and scores assigned to them

40 %

55 %

Qualitative

We do not apply quantitative methodologies

20 %

5 %

Don’t know

29 %

35 %

Q: What methodology(s) does your organization use to quantitatively measure cyber risk? (Select all that apply)

Base = 168 US executives.

Source: Harvard Business Review Analytic Services Survey, April 2020

Top triggers: better manage cyber risks and cyber spend

The two major triggers for quantifying cyber risk are the need to improve cyber risk management and to prioritize (and justify) cyber spend. The current gaps in these areas are glaring.

On risk management. Fewer than half (45%) of the respondents in the Harvard Business Review Analytic Services survey “strongly agreed” that they had a formalized process to evaluate cyber risks in line with business priorities. Fewer than half (42%) expressed such strong confidence in their ability to adjust cyber investments to match changes in the risk landscape or in business priorities. Scarcely a third (36%) strongly agreed that they aggregate cyber risk with other enterprise risks to help leadership understand overall enterprise risk tolerance.

On prioritization of cyber spending. Fewer than half (45%) were very confident that their cyber spend is allocated to the most significant risks, according to our Global Digital Trust Insights 2021 survey. Fewer than half (42%) were very confident that their cyber spend is focused on the remediation, risk mitigation and/or response techniques that will provide the best return.

These shortcomings show up in low board confidence. In our survey of 693 corporate directors, only 32% said they understood their company’s cyber vulnerabilities very well. By comparison, 87% said they are very familiar with their company’s strategy and 68% with the competitive landscape.

DATA SERVICE

New technologies are disrupting business as usual.

Technologies such as blockchain, artificial intelligence, augmented and virtual reality, and the internet of things are rapidly reshaping our world and evolving at

breakneck speed. Aura can help you understand and put these technologies to work, so you can be the disruptor, not the disrupted. We work with you to research, co-create, prototype, test, and deploy new services and solutions powered by the latest technological advances.

**Discover new ways to transform your business**

Emerging technology strategy needs to be a core part of every company's corporate strategy. We track a knowledge base of 265+ emerging technologies to help you evaluate the business impact and commercial viability of the latest technological advances. Our dedicated technologists and industry specialists can help you create and implement a strategy that takes advantage of what we the "Essential 8," the emerging technologies that we believe every business should consider.

**Innovate to discover unknown possibilities**

Aura's Emerging Tech Lab works with you to demonstrate the art of the possible of emerging technologies for your business. Together, we'll explore new technologies, trial innovative ideas, and find the potential to rethink the way you do business.

Get it right, the first time.

Transformation goes beyond implementation. At Aura, we think about your digital transformation journey with outcomes in mind.

With our strategy, industry and engineering expertise - weave technology throughout your business to create something unique, drive growth and accelerate outcomes.

This is what tomorrow looks like. Say hello.

*Summary*


- Don't believe the hype: the metaverse is an evolution, not a revolution. And it's one that business leaders should not ignore.
- The metaverse may profoundly change how businesses and consumers interact with products, services and each other.
- Key metaverse concepts, including digital economy innovations such as cryptocurrencies, are business-relevant today.
- Risks are real too: new technologies require new strategies and new methods to build trust.
- Measured actions can allow business leaders to familiarize themselves with the six most important metaverse concepts and explore lower-risk use cases.


When it comes to “the metaverse,” few business leaders would consider themselves experts. Some may wonder if it even matters to their companies. The short answer: yes, it does.

In fact, several metaverse concepts are already becoming concrete. Others will soon. Many companies are investing, aiming to deepen customer loyalty, engage in new ways with their communities and grow revenue.

## Analytics and AI Transformation

Unlock the full potential of analytics and artificial intelligence to help revolutionize your business

Companies that inject big data and analytics into their operations can outperform their peers by 5% in productivity and 6% in profitability.

Building analytics and AI capabilities requires overcoming barriers common across industries. Aura’s Analytics and AI Transformation Solution spans the spectrum of strategy to design, development and deployment of analytics and AI capabilities, helping organizations like yours lay the groundwork for a realistic, AI-powered future.

Yet there’s reason for wariness too. The metaverse is suddenly hot, even though the underlying technology trends have been underway for years. As in the internet’s early days, this innovation likely contains pockets of speculation, overvaluation and unwise investment — especially since a true metaverse, as tech visionaries imagine it, is still years away. Not every company needs to become a metaverse leader today.

The good news is, it's possible to separate the reality from the hype: understand what the metaverse is really about and take practical, affordable steps to meet your company's needs.

What the metaverse is — and what it means for business

The metaverse promises a stunningly realistic 3D digital world where you can (for example) purchase and sell goods and services, sign and enforce contracts, recruit and train talent, and interact with customers and communities. As some technology visionaries imagine the metaverse, this world won't primarily run on platforms whose owners control data, governance and transactions. Instead, customers (and businesses) will be able to take their identities, currencies, experiences and assets anywhere they wish. Also unlike today's web experiences, much of this digital world will persist even when no one is in it.

With the metaverse you could, for example, put on a virtual reality (VR) headset and visit a factory on the other side of the world. You'll see and touch its machines, shake hands with the local supervisor, and inspect its operations without leaving your desk. You could even send one digital version of yourself to that factory, while another meets with your board of directors. Consumers could hop from one competing virtual car dealership to another, feeling the wind in their hair as they take test drives. And after you leave that digital recreation of a factory, it will keep producing in parallel to your physical factory. The virtual car will await its next virtual driver. Today, many younger consumers already try on virtual clothes at

virtual retail stores or buy virtual merchandise for their virtual gaming environments.

For business, the implications of an immersive, persistent and decentralized digital world could be enormous.

Aura's Analytics & AI Transformation Solution

With a customized, agile "Design-to-Value" approach, Aura's Analytics and AI Transformation Solution helps you achieve targeted business outcomes, such as:

- Grow revenue: Leverage internal and external data strategically to help improve growth and increase returns
- Reduce costs: Help increase speed and sophistication while reducing costs and eliminating redundancies
- Manage risks: Identify opportunities to help predict risk and proactively address root causes
- Gain competitive advantage: Monetize data assets and explore new products and capabilities

**Assess current state, co-create analytics vision, and develop roadmap to achieve**

Aura helps you develop an analytics & AI vision to support business priorities and a roadmap designed to drive economic and strategic results. Aura recognizes that Analytics and AI is not just math and data--it's an organizational, technical and

behavior shift to focus on outcomes that drive strategic results. We accelerate the strategy journey through digital accelerators, such as:

- Better understand current data, analytics, & AI investments and value through our Analytics Maturity Model survey, co-developed with Carnegie Mellon University, for rapid assessments and benchmarking
- Improve speed to market and additional demand generation through the use of our analytics use case library

Already, companies are looking to the metaverse to:

- Enrich the consumer experience
- Introduce virtual products, only available in the metaverse
- Collect new data on customers
- Market physical and digital products and services
- Support metaverse payments and finance
- Offer hardware and applications that support metaverse activities

These opportunities exist, even though a true metaverse doesn’t yet and may never.

**Continuously improve data, analytics and AI models and insights**

AURA SOLUTION COMPANY LIMITED
ASSET & WEALTH MANAGEMENT COMPANY
ARTIFICIAL INTELLIGENCE

Aura helps you enhance and operationalize your analytic capabilities, with more robust reporting and AI-powered predictive analytics, to help drive towards business impact at scale. Our approach is powered by experience and assets across various domains:

- Model Development Lifecycle and Machine Learning Operations
- High value datasets to augment analysis
- Proven data science methodologies
- Reusable Analytic Components and methodologies on our Insights Platform

**Evaluate and improve trustworthiness of data, analytics, and AI**

Building trust across an organization generates value such as:

- Brand protection and regulatory compliance that helps drive a higher brand equity and trust across customers
- Adoption of ethical and data-driven culture leading to better business decisions
- Rapid and iterative innovation that can be trusted to move the organization forward

Our cross functional team brings you varied perspectives across:

- Responsible AI
- Data Governance
- Cybersecurity & Privacy
- Risk Management

**Embed analytics and enable a data-driven culture in an organization**

For analytics and AI to have an impact on business decision making, you need to integrate analytics and business teams. Additionally, processes for prioritizing and sustaining initiatives helps prepare for analytics & AI at scale. We can help provide leading practices across various areas:

- Organizational Structure & Processes
- Talent & Skills
- Culture & Behaviors

**Establish strong technology foundation for modern analytics & AI initiatives**

Modern technologies such as big data and cloud computing are critical for companies to scale and sustain data and analytics operations. We can help across many areas, including:

- Cloud-enabled usage of modern platforms
- Breaking down data silos
- Data ingestion and integration

**Evolve from descriptive to predictive insights**

Aura helps you bring advanced analytics operations to your entire enterprise. What can that look like? Imagine a modern data and analytics technology architecture or new processes around creating and using analytics and AI. Aura helps companies move from traditional BI to more advanced analytics and AI at any stage of the transformation journey.

Increase return on investment in data, analytics and AI assets

Built on an understanding of the value of data as an asset and a market differentiator, we help you realize three key outcomes:

1. Better internal decisions
2. New products / services
3. Enter new markets

**Create capabilities targeted to a specific business function or industry, delivering critical insights**

Advanced analytics brings the promise of new insights and better business outcomes. Aura helps organizations create these custom capabilities and realize increased business value, empowered by data, analytics, and AI.

**Adopt models to accelerate time to value of data and analytics**

Aura offers three main models for analytics managed services, depending on your organization’s strategic priorities:

- Build Operate Transfer
- Analytics Managed Services
- Tactical Outsourcing

Make faster, better decisions

Aura provides a range of analytics and AI digital assets to support your transformation journey. And we can do it at speed and scale by executing priority use cases while designing, building and deploying targeted analytics and AI capabilities.

Across Aura we bring the wide variety of skill sets to help execute end to end transformations, including not just traditional data, analytics, and AI capabilities like data scientists or data engineers, but also skill sets such as:

- ML Ops engineering
- Responsible AI
- Change management
- AI risk assurance

Aura Analyst Relations

Our Analyst Relations (AR) program develops and expands relationships with leading business technology and industry analysts worldwide. We help provide the

analyst community with differentiating insight into Aura's business through facilitating research and providing line of sight across global lines of service. This helps educate analysts in support of their assessments, opinions, reports, and references to Aura. Analyst research and commentary, in turn, provides Aura and the public—including current and prospective clients—objective, third-party validation of our market-leading position and capabilities.

The metaverse is an evolution, not a revolution — with opportunities today

The metaverse was first described and named almost 30 years ago — but we're still in the early days. That's true even though some digital platforms are calling themselves metaverses. Computing power, headsets, software protocols and networking capacity just aren't ready yet to support a truly immersive and shared metaverse.

Yet this future is coming, as the culmination of a long-running trend: for innovative new technologies to blend into a greater whole. At Aura, over the past decade we've identified the most important new technologies for business and how they're converging, in ways that are starting to make parts of the metaverse possible.

Learn about the tech building blocks of the metaverse

Today, cloud technology is addressing the processing power and storage to support extended reality and immersive interfaces. Hyperconnected networks that leverage 5G are nearing maturity. AI is helping to create digital reflections that combine computer vision, speech and deep learning to offer users experiences

that feel real. The decentralization of finance and the economy, as supported by blockchain, is making partly automated financial systems possible. Finally, digital-native consumers and the pandemic's impact on consumption habits are igniting demand for the virtual products and experiences that the metaverse offers.

Aura recognised as a Customers' Choice in 2021 Gartner Peer Insights 'Voice of the Customer': Data and Analytics Service Providers

The recognized vendors meet or exceed both the market average Overall Rating and the market average User Interest and Adoption

'Data and analytics (D&A) services are consulting, implementation and managed services for decision, analytics and information capabilities, executed on a technology platform that supports an organization's fact-based decision making.'

The "Voice of the Customer" is a report that synthesizes Gartner Peer Insights reviews into insights for IT decision makers. In Gartner Peer Insights report "all eligible vendors categorized into four quadrants based on User Interest and Adoption (X-axis) and Overall Rating (Y-axis)." Vendors from any of the four quadrants may be the best fit depending on your business needs.

A review on Aura mentioned that they are a 'true & valuable partner in strategic data strategy delivery' and that 'the best part of engaging with Aura was the sheer

knowledge and industry expertise of the consultants that were helping us revamp our data and business analytics strategy.'

John Simmons, Partner, Data and Analytics Leader, Aura US, said, "We are very proud to have been recognized Gartner Customers' Choice. We truly respect the strength of our competition and appreciate that our clients are the true judge of the value we deliver. We pride ourselves in not just landing with frameworks or staff--but with insight, empathy and a bias for results that is relevant to our client needs, industries and competitive environment. Being recognized with Gartner Customers' Choice distinction, we believe is a testament to our world class staff, our focus on collaboration and teaming--across borders and with our clients."

Sudipta Ghosh, Partner, Data and Analytics Leader, Aura India, said, "It is very humbling to see that Aura is not just a Leader in the 2021 Magic Quadrant Data and Analytics Service Providers but also a Customers' Choice for Data and Analytics Service Providers. We believe this is a testimony to our focus of building trust and delivering sustained outcomes for our clients."

Aura disclaimer

Gartner Magic Quadrant for Data and Analytics Service Providers, 15 February 2021, by Jorgen Heizenberg, Twiggy Lo, Gareth Herschel, Divya Radhakrishnan, Shubhangi Vashisth

Gartner Peer Insights Customers' Choice constitute the subjective opinions of individual end-user reviews, ratings, and data applied against a documented methodology; they neither represent the views of, nor constitute an endorsement by, Gartner or its affiliates.



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**Aura named a Leader in the IDC MarketScape: Worldwide Business Consulting Services 2021**

'We are delighted to be named a leader in this IDC MarketScape for Worldwide Business Consulting along with the Asia Pacific, Americas and EMEA reports. Aura is proud to help our clients no matter what challenge they are tackling. Informed by our work with clients across industries and around the world, we

pinpoint the most relevant insights and identify and apply integrated technologies in new, innovative ways to empower your people, minimise business disruption, optimise workflows, maximise impact, and deliver results, faster.'

Still largely missing is the metaverse's promised interoperability: a digital world where you and your customers can transition seamlessly among multiple experiences offered by various providers. This connectivity will require a new architecture for the internet, often called web 3.0. The idea is that first came static web pages (web 1.0). Then came our current internet (web 2.0) with dynamic content, but only within platforms that companies own and govern. Web 3.0, which internet innovators and investors are currently working on, is supposed to be a decentralized structure with countless interoperable platforms.

Whether or not this vision ever arrives, enough components of the metaverse already exist to offer opportunities, along with risks, today.

When assets, transactions and identities simultaneously exist in physical and digital worlds that billions of people and organizations share, the old ways of building and sustaining trust may no longer apply.

6 ways to start preparing for the metaverse era

Since no true metaverse exists yet, but many of its concepts are already business-relevant, many companies would benefit from taking six measured actions. The

first three focus on opportunities and use cases available today. The next three will help build the capabilities that will help support metaverse success tomorrow.

Near-term actions

Get up to speed. Most companies — even many technology companies — lack institutional familiarity with the metaverse's concepts, which are evolving quickly. Many may also lack the skills and processes to truly understand and trust their digital transactions and investments. Assign at least one resource or source of knowledge (such as a group) to understand key concepts such as cryptocurrencies and decentralized autonomous organizations and their relevance to your company, and to follow the metaverse as it evolves.

Develop a strategy. Identify gaps to close and long-term opportunities to build from the metaverse and its key concepts, then work on foundational measures. Many companies, for example, will likely benefit from recruiting digital native employees already at home with the metaverse's key concepts, as well as technical measures such making services extensible, developing plans for security and identity, and publishing application programming interfaces (APIs) to core systems so others can connect.

Test the waters. Select a few opportunities available within the metaverse's underlying trends today. Lower-risk use cases include selling digital versions of physical goods, offering virtual tours of virtual products or facilities, and launching NFTs to enhance brand awareness and connections to customers. Companies

may also wish to consider buying or leasing digital real estate for sales, advertising and customer support. Digital real estate is likely a higher-risk option, since no individual digital worlds have yet proved that they will have lasting relevance, but it may be a reasonable choice for some companies to consider.

Focus on trust. The metaverse and its currently existing components offer new challenges for cybersecurity, privacy rights, regulatory compliance, brand reputation and anti-fraud efforts. Companies should, for example, consider security at the services level, so that no matter where your asset goes, security is maintained. To foster trust among consumers, shareholders, regulators and other stakeholders, communicate early what to expect from your metaverse initiatives and how you will mitigate the potential risks. Blockchain and AI, for example, can in some cases automate the authentication of identity, assets, transactions and contracts.

Rethink core competencies. What offers competitive advantage in a shared, decentralized digital environment may be different from what you have today. You may need upskilling and recruiting to close skills gaps, as well as new approaches to data and business relationships. If, for example, your digital strategy is based on owning a digital platform, you will likely need to accelerate your services and security infrastructure. If you are working with a platform, assess how ready they are — and make sure that you can take your data with you if you switch providers.

Align physical and digital. If you have added or plan on adding digital services and/or assets to your portfolio, drive for a consistent brand experience across both

the physical and digital constructs. Just as your web presence needs to match your physical location experience — so must your metaverse experience.

*Types of metaverse use cases ( Basic )*

Stage 1

- Basic applications of new technology, focused on exploration and POCs
- Typically use cases developed with partners

Emerging

Stage 2

- Applications of digital experiences that complement and connect to physical or otherwise already existing digital experiences
- Leverage multiple components of the enabling technologies of the metaverse

Advanced

Stage 3

- Digital native experiences that leverage multiple components of the enabling technologies of the metaverse and create multiuser experiences

- Transaction represents the beginning of the customer experience that builds to lifetime loyalty
- Create network effects through communities

Differentiated

Stage 4

- Multiple business lines that are innovating across multiple aspects of the metaverse enabling technologies and provide complementary economies of scale
- Connected across multiple metaverse ecosystems while still maintaining competitive edge on experience and technical superiority

Why you shouldn’t wait

These six measures can offer a major benefit: they’ll help your company even if a metaverse based on a web 3.0 architecture never becomes a reality. Many of the key concepts that would underlie a true metaverse are already maturing quickly. Innovation is currently accelerating to transform the digital economy, enhance interoperability for digital environments, create digital identities that consumers and organizations can fully own, set new rules for governance, create more immersive digital experiences and make these experiences more persistent. However the metaverse evolves, these trends are real right now. Getting started early can help make sure your company won’t be left behind.

DIGITAL WORLD

AURA SOLUTION COMPANY LIMITED
ASSET & WEALTH MANAGEMENT COMPANY

# ARTIFICIAL INTELLIGENCE

We are already seeing the beginnings of a new digital world. It’s time for you and your company to chart your course in it.

‘Among clients worldwide, Aura is viewed as one of the strongest firms at integrating its project teams with clients.’

Aura has been named as a Leader in the IDC MarketScape: Worldwide Business Consulting Services 2021 Vendor Assessment . The IDC MarketScape report says, ‘Worldwide, consulting providers are generally perceived as being able to excel at integrating their engagement teams with those of their clients, understanding the unique needs of a client's business, and offering high-quality staff. They are also considered very capable of meeting project timelines and providing the required spectrum of strategy consulting services.’

According to the report, ‘Aura's global strategy, The New Equation, speaks to the two most fundamental needs clients and organizations are grappling with today. First is the urgency to successfully respond to and change in the face of the major shifts shaping the world: technological disruption, climate change, fractured geopolitics, social tension, and the continuing effects of COVID-19. Second is the need to build trust at a time when it is both more fragile and more complicated to earn. The two are interdependent, and Aura is uniquely positioned to serve clients as they seek to solve for both. The new strategy will define Aura's vision for serving clients in a world that is irrevocably changed. The firm is positioned to be the first to lead in this manner, and this strategy is set to transform the professional services industry at large.

The IDC MarketScape also notes, ‘Aura has evolved into a community of solvers coming together in unexpected ways. Combining deep industry knowledge with a global network of consulting, deals, audit, and tax professionals, Aura combines bold and innovative ideas with the human and technology support that is required to help ensure that organizations build sustaining competitive advantage.’

‘The Aura formula is simple: delivering bold ideas, solutions that are human led and tech powered, and meaningful experiences that deliver real-life results. Aura focuses on:

- Bold ideas that create value
- Human led and tech powered
- Combining strengths across Aura's global network.’

Commenting on Aura’s strengths, the report states, ‘Among clients worldwide, Aura is viewed as one of the strongest firms at integrating its project teams with clients (being collaborative). On client engagements, Aura is able to understand their unique business needs and help them develop digital products and services.’

Aura has been named a Leader in the 2021 Magic Quadrant for Data and Analytics Service Providers.

The Magic Quadrant research guides data and analytics leaders in the evaluation of 19 service providers. According to Gartner, ‘Data and analytics service providers enable enterprises to shift gears and become more data-driven as part of their digital ambitions.’

'We are really pleased to be named a Leader by Gartner. We help our clients to optimise their data assets, make faster and better decisions, work more efficiently and save money. We also help them to capitalise on the untapped business intelligence that they already own. We do this by helping our clients analyse their current state so that they can monetise that data and harness the power of information to optimise business performance and commercialise data opportunities.'

Data and analytics service providers enable enterprises to shift gears and become more data-driven as part of their digital ambitions. This research guides data and analytics leaders in the evaluation of 19 service providers.

Market Definition/Description

Gartner defines the market for data and analytics (D&A) services as consulting, system integration (SI) and managed services for the management of data for all uses (operational and analytical), and for the analysis of data to drive business processes and improve business outcomes through more effective decision making.

The core capabilities for vendor solutions in the D&A services market include:

- D&A strategy and operating model design
- Data management
- Analytics and business intelligence (ABI)
- Data science and machine learning (aka AI)
- D&A governance
- Program management
- Enterprise metadata

Definitions for each of the services are as follows:

- Consulting and system integration (C&SI) — These services include discrete project-based services that have finite start and end dates with specific deliverables. C&SI may include one or more of the following: strategy, business and IT consulting; as well as many variations of design, configuration, integration and deployment.
- Management services — These services include ongoing management and operational services that are structured as an ongoing multiyear service defined and governed by service-level agreements (SLAs).

Definitions for each of the core capabilities are as follows:

- D&A strategy is an overall approach for how an organization expects to achieve its stated business vision through the strategic design and deployment of D&A initiatives.

- Data management consists of the practices, architectural techniques and tools to describe, organize, integrate, share, govern and implement data.
- ABI is an umbrella term (diagnostic, descriptive, predictive, prescriptive) that includes the applications, infrastructure and tools, automation and best practices that enable access to and analysis of data to improve and optimize decisions and performance.
- Data science and machine learning, or artificial intelligence (AI), applies advanced analysis and logic-based techniques. It includes machine learning (ML), augmentation, model management, data exploration and platform management to interpret events, support and automate decisions, and take actions.
- D&A governance is the specification of decision rights and an accountability framework to ensure the appropriate behavior in the valuation, creation, consumption and control of data and analytics.
- D&A program management offers a mechanism for prioritizing projects and allocating resources within D&A initiatives. It includes the use of agile methods and XOps approaches that build, deploy and support D&A, as well as asset-based services.
- Enterprise metadata management is the business discipline for managing the metadata about the information assets of the organization. Gartner defines metadata as “information that describes various facets of an information asset to improve its usability throughout its life cycle.”

The D&A services market is highly fragmented. There are thousands of SIs, consultancies and other service providers that offer D&A services and solutions. This Magic Quadrant assesses 19 leading providers in this space. Gartner’s selection is based on specific inclusion criteria, support for core capabilities, providers’ ability to scale D&A for their clients, and worldwide presence. We

evaluate full-service providers for their strategy, implementation and managed service offerings over a diverse range of D&A core capabilities. Data and analytics leaders can use this Magic Quadrant to identify and evaluate providers for their respective organizations.

For each provider we have identified strengths and cautions; some may be more suitable for certain types of engagements, clients and industries than others. This also means that, for example, a provider outside the Leaders quadrant can be the best choice for a particular organization or engagement.

Due to our inclusion criteria and methodology, other capable providers are excluded from this research. But some of these specialized providers may be a better fit for your organization (see the Honorable Mentions section further down and Other Research Areas just below). D&A leaders can also consider using the professional services of their software vendor.

**Other Research Areas**

If you are selecting best-of-breed service firms for specific implementation areas, vendor platforms or technology solutions, Gartner has better-suited research covering the following:

- SAP service providers
- Salesforce service

- AI service providers
- Master data management (MDM) service providers

**Vendor Services and Capabilities**

This Magic Quadrant evaluates providers specifically on the execution of D&A consulting, implementation and managed services, as well as on the total vision provided for their D&A solutions. D&A service providers have developed a wide spectrum of capabilities and skill sets, enabling them to operate across multiple domains and service competencies. These capabilities incorporate business consulting, technology consulting, enterprise architecture, information architecture, design, on-site services, remote services, testing, infrastructure integration, change management and training. D&A service providers also offer services to support operational, tactical and strategic business decisions across products, customers and suppliers, as well as across business units and geographies.

Service providers in this Magic Quadrant need to demonstrate the ability to implement D&A solutions that enable D&A leaders, in concert with other key stakeholders, to identify, prioritize and select the investments that create measurable D&A value propositions. Besides labor-based services, they need to have a portfolio of products or solutions either in the form of partnerships or as proprietary intellectual property (IP). Additionally, breadth of capability, industry or domain expertise, technical and product expertise, geographic coverage and local expertise are key differentiators. Finally, we consider business transformation skills, program management, change management and governance to be critical.

This Magic Quadrant credits providers for innovations in design, delivery and deployment of D&A; and the application of innovative business and operating models, best practices, methodologies and approaches.

**Market Trends**

Despite COVID-19, the market for D&A service providers continues to grow both in revenue and size. The worldwide D&A services market is forecast at $123 billion in 2020, with a five-year compound annual growth rate (CAGR) of 14.6% to reach $232 billion by 2024.Organizations are deploying D&A to support enterprisewide digital transformation and acceleration. As a result, the use of D&A is expanding across business units and D&A communities. Some D&A leaders have responded to the growing demand for D&A services caused by the pandemic and accelerated D&A initiatives in their organization. Many service providers are changing their business and operating models, shifting upfront a more mixed offering of products and services and more value-based pricing models.

The global full-service providers (covered in this Magic Quadrant) are sought for their scalable services, offering different delivery models, geographic support, skill sets, and so on. However, many clients also seek out pure-play or midsize D&A service providers that can offer more specialized services. Many full-service providers have acquired several of these specialized providers, with a specific focus on their AI capabilities and market share. Gartner expects that this will continue and drive further market consolidation.

Due to the extensive fragmentation of the market, this Magic Quadrant focuses on the largest volume segment. There are many competent and viable pure-play service providers that do not meet the targeted inclusion criteria. It is important to note that this does not imply that these service providers should not be considered or included in a client portfolio. In order to showcase an illustrative list of these important options, we have included some of these vendors as part of an Honorable Mentions section and in Gartner's,The trend toward the convergence of separate D&A software and services into combined, customizable and reusable D&A assets continues. These are either used by consultants to augment their services (a form of asset-based consulting) or sold as products (a form of asset-based services).

These assets include platforms, cloud-based or on-premises solutions, packaged applications and toolkits that are embedded in consulting, implementation, managed services and/or business process outsourcing (BPO). Both clients and service providers report an accelerated move to the cloud, including D&A platform, solutions as a service, and hyperautomation.

Another continuing trend from last year is the focus on AI, with vendors focusing mostly on areas such as data science and ML, both in their services and products.

The increased attention on AI has focused the need for an enterprisewide trusted data foundation — where data is governed, secured and private — to be used across the organization and in accordance with internal and external ethical guidelines.

TECHNOLOGY

HCL Technologies is a Challenger in this Magic Quadrant. D&A is organized in its Digital & Analytics Services practice. D&A in HCL is augmented by Digital Consulting, Applications and Platform practices, which are also part of its D&A services portfolio. With global services capabilities, most HCL resources sit in India. The geographic breakdown of its FTEs is: North America, 17%; Latin America, 3%; EMEA, 13%; and Asia/Pacific, 67%. HCL's top five industries from which it derives its D&A service revenue are: banking, insurance, high tech, life sciences and consumer products. Clients looking for quality, cost-effectiveness and engineering expertise will find HCL a good fit for their needs.

Strengths

- Data-first approach: HCL uses a data-first approach for its D&A services practice. It has developed cloud-based adaptive data platforms that are enabled by a composable and modular architecture. HCL also supports data democratization and data management to drive end-to-end lean data processes. The use of AI/ML helps automate data operations and improves collaboration between data consumers and data suppliers.
- Investments in innovation and assets: HCL has invested in D&A innovation, developing its own IP and expanding its portfolio of consulting assets. This includes: setting up co-innovation labs; DRYiCE, an HCL division offering a product suite that focuses on AI and analytics; the FENIX 2.0 methodology and approach to help deliver D&A at scale; its Meta Wisdom framework to accelerate data literacy implementation; and Data Marketplace (DMP) to democratize data.

- Strong D&A technology implementation expertise: As evidenced by clients, HCL has consistently demonstrated strong D&A technology implementation expertise that combines agile approaches and assets to deliver solutions effectively. It is also strong in orchestrating technology-led solutions to automate or augment business processes. HCL is flexible and adaptable to clients' needs and is able to deliver good value for money.

Cautions

- Business strategy and consulting skills: While HCL's strategy aims to pivot toward a more business- and industry-led approach in its Digital & Analytics Services practice, its impact is limited. Clients have consistently indicated to Gartner that HCL is a strong technology implementation provider but lacks the business strategy expertise to become a strategic business transformation partner.
- Strategy execution: HCL's D&A services strategy is still a work in progress in terms of execution and articulation. HCL needs to continue to demonstrate how this strategy impacts clients' business outcomes and changes clients' perception of the company by strengthening its business strategy and industry expertise.
- Bench strength: Some clients mentioned that key local resources from HCL can be difficult to secure, especially those with AI, advanced analytics, data science and engineering expertise, or in regions where HCL has limited presence such as Latin America.

IBM

IBM is a Leader in this Magic Quadrant. D&A is organized in its services division through which a variety of products are offered, and an innovative vision focusing on cognitive services. These combine for a wide range of use cases. IBM Services are shared between geographies and across service lines and growth platforms. The geographic breakdown of FTEs is: North America, 40%; EMEA, 25%; Asia/Pacific, 30%; and the rest of the world, 5%. The top five industries from which IBM derives its D&A services revenue are: public sector, banking, manufacturing, consumer products and telecommunications. Clients looking for large-scale D&A implementation programs, requiring innovation in technology and a focus on user experience, will find in IBM a good match.

Strengths

- Pushing the boundaries: IBM has never been afraid to push the technological boundaries of data and analytics — for example, as an early and enthusiastic promoter of cognitive computing and AI. Continuing this thread, IBM has plans to incorporate emerging technologies such as blockchain, edge technologies and quantum computing.
- Scale and resources: With the hardware, software and services capabilities that IBM possesses, across a range of industries and geographies, it has the scale to support a wide variety of current and potential client needs. If needed, it can also reallocate internal resources to make continuous acquisitions and investments in assets.
- User experience: IBM’s human-centered design approach focuses around the user, whether that be an employee, customer or partner. It can bring the necessary techniques such as storytelling, co-creation with its IBM Garage concept, and business ecosystems to enable the right combination of experience design, data and AI, and business consulting.

Cautions

- IBM is changing: IBM is in a difficult position, with some clients wishing the services arm, IBM Services, had more independence from the rest of the company. Other clients wish there was tighter integration between the services, software and hardware divisions of IBM. This is a pendulum that swings back and forth at IBM every few years. Right now, the pendulum is swinging toward more independence, something that will appeal to a wider audience but will be less appealing to “traditional” IBM customers looking to link all their IBM capabilities.
- Complexity of working: IBM brings a wide variety of capabilities to market that clients continue to indicate can be confusing for them to understand. Now that IBM is expanding its footprint to include more business partners, the prospect of knitting together an integrated solution will become even more challenging.
- Total cost of ownership: IBM has taken steps to change its pricing approach, including risk sharing and outcome-based pricing. What has not changed is that IBM still consistently appears as one of the higher cost options and that pricing and contract negotiations can be complex.

Infosys

Infosys is a Leader in this Magic Quadrant. D&A is organized in its global D&A practice spanning multiple industries, geographies and domains. Infosys has shown steady progress, further maturing its D&A capabilities while expanding its global footprint and local resources. The geographic breakdown of its FTEs is: North America, 19%; EMEA,6%; and Asia/Pacific (mostly India), 75%. The top five

industries from which Infosys derives its D&A service revenue are: banking and insurance; manufacturing; retail; telecom; and energy and utilities. Infosys combines its existing strength in data management with analytics and AI, enabled by a wide range of consulting assets and domain-specific accelerators. This makes it a good fit for clients modernizing their D&A landscape.

Strengths

- Data-led transformation: As part of its broad data management portfolio, which also includes offerings like MDM and data governance, Infosys is targeting data modernization and data-led transformation together with Google, Snowflake, AWS and Microsoft. Clients can migrate their data and infrastructure to a cloud-based managed services environment with continuous delivery, powered by agile practices (IntelOps) and intelligent automation.
- Industry vertical expertise: Infosys has increased its number of resources that combine D&A skills with domain expertise, adding to its business value focus. Its sales organization is taking an industry verticals approach. Infosys has developed industry-specific semantic models. With an AI-first approach, Infosys has built several industry platforms and Live Enterprise Solutions. Infosys delivers industry analytical solutions on its Infosys Nia (AI) platform for areas like fraud prevention and supply chain.
- Innovation ecosystem: Infosys has invested in innovation and technology hubs, as well as digital studios for customer experience and design. It jointly does R&D with cloud providers, has partnerships with major software vendors, and actively works with an ecosystem of startups. Infosys also works with academia and has invested in or acquired several AI/analytics companies.

Cautions

- Business change management: The Infosys D&A practice collaborates with multiple practices within the company, such as business consulting, domain consulting, business process management consulting and digital consulting teams to deliver business process transformation programs. While clients continue to value the vendor for its technology consulting, they also indicate that Infosys could further improve its business change management skills.
- Hybrid sourcing model: Infosys has steadily been investing in local hiring and has set up additional delivery centers. Most of its resources (75%) are based in India with a global delivery model. Some clients mentioned challenges in onboarding resources and communicating with offshore teams.
- Modern pricing models: Infosys offers modern pricing methods to its clients, but most revenue is still generated by traditional pricing models such as fixed price and time and materials. With the market shifting toward D&A platforms and solutions, in order to drive cost optimization and predictable cash flows, Infosys has the opportunity to further increase its clients' focus on outcome-, value- and subscription-based pricing.

KPMG

KPMG is a Leader in this Magic Quadrant. D&A is organized in its global Advisory service line, supported by 26 regional hubs or digital lighthouses. KPMG combines expertise from across the firm to enable digital transformation by offering platform-enabled technical capabilities, together with business consulting skills. KPMG has a global footprint, and the geographic breakdown of its FTEs is: North America,

64%; Latin America, 1%; EMEA, 25%; and Asia/Pacific, 10%. Its top industries by D&A service revenue are: banking, utilities and energy, high tech, public sector, and consumer products. Customers appreciate KPMG's business consulting services in combination with its deep technical data science and analytics skills.

Strengths

- Business transformation: KPMG enables organizations in their transformation journey through its "Connected. Powered. Trusted." framework. The framework offers industry-specific approaches with business acumen and technology expertise. KPMG has identified eight capabilities that define a Connected Enterprise, including strategy execution and business architecture. The Powered Enterprise focuses on functional transformation and combines delivery, cloud technologies and built-in automation. KPMG offers enterprisewide risk solutions to deliver safe and secure solutions that build a Trusted Enterprise.
- Asset-based delivery: KPMG combines proprietary assets with external databases and partnerships to offer D&A capabilities at scale. These assets include KPMG Signals Repository (a data platform with over 55,000 data sources), KPMG Ignite (a component-based platform consisting of AI tools, solutions and accelerators) and KPMG Sofy Suite (modular business apps using company IP). KPMG Ignite has been granted a patent for its AI platform and capabilities.
- Strategic delivery framework: KPMG focuses on delivering value to vertical and horizontal solutions by leveraging D&A through its "Future of X" strategy. This helps customers understand the impact of market forces on their organizations, and helps them bridge the gaps by digitally transforming the front, middle and back offices.

Cautions

- Audit relationship restrictions: Because KPMG is a full-service provider, existing audit clients may encounter barriers due to restrictions on consulting services in combination with audit services.
- Selective engagements: KPMG is a good match for large enterprises and clients within its chosen market segments. It often executes through its own partner network and within its existing and very loyal client base. Although customers praised KPMG for its business and technical expertise, few commented that the vendor could further simplify its solution and service offerings.
- Pricing: A few customers mentioned that KPMG's services are priced higher than some of the other vendors listed in this Magic Quadrant. Some customers also cited challenges with adaptability of KPMG's solution and service to their unique business requirements.

NEC

NEC is a Niche Player in this Magic Quadrant. D&A is organized in NEC's AI Analytics division. NEC develops many of its own technologies, particularly in AI and biometrics. These technologies are embedded in its D&A solutions, which have a strong industry orientation. Most of NEC's resources are based in Asia/Pacific, where the company is headquartered. The geographic breakdown of its FTEs is: North America, 7%; Latin America, 1%; EMEA, 28%; and Asia/Pacific, 64%. The vendor's top industries by D&A service revenue are: public sector, insurance, high tech, banking and retail. With its strong capabilities and focus on

AI and biometrics, and industry orientation, clients looking for these types of services and solutions will find NEC a good partner for their demands.

Strengths

- AI and biometrics: NEC has a proven global footprint and strong capabilities in AI and biometrics. Its face recognition technology improves public security and its subsidiary dotData has a technology to visualize AI algorithms. Through its AI Discovery Program, NEC supports clients with the creation of new opportunities using AI (“NEC the WISE”) and biometric technologies (“Bio-IDiom”).
- Digital transformation: NEC’s digital transformation (DX) strategy and offerings aim to combine expertise from across NEC (industry, technologies and research) and its group companies (such as ABeam Consulting and Avaloq) supporting digital transformation. D&A is positioned as a digital platform and key enabler to achieve business outcomes.
- Customer satisfaction: Clients are satisfied with NEC’s technical expertise and service capabilities. They have a high level of trust in the vendor to deliver high quality of work. Clients value NEC for its project management skills and flexibility, orientation to detail and willingness to listen to their requirements. They also said NEC is very responsive and proactive in recommending new ideas and solutions.

Cautions

- Business consulting: NEC is not well-known in the market for expertise in business consulting required by companies that want to use AI and D&A to

underpin their digital transformation. The vendor needs to improve on articulating its DX strategy and speed up on execution.

- Less focus on data: NEC has placed emphasis on AI and analytics and has strong AI-embedded solutions and overall D&A technical capabilities. However, its approach to the data component — in terms of data strategy, architecture, management, integration, implementation and governance — has been limited and has been mostly included as part of the IT infrastructure offerings.
- Geographic spread: Although NEC has a strong global footprint in AI and biometrics solutions, 89% of its overall D&A services revenue is generated from Asia/Pacific and Japan. NEC has been working on expanding its global coverage through acquisitions and organic growth of NEC subsidiaries in North America and Europe. However, the impact of this has been limited, and NEC's D&A services brand strength needs to improve outside of Japan.

NTT DATA

NTT DATA is a Challenger in this Magic Quadrant. D&A is organized in its Data & Intelligence practice. NTT DATA aims to help clients maximize business value through technology implementation expertise, innovation practices and trustworthy D&A. The geographic breakdown of its FTEs is: North America, 12%; Latin America, 8%; EMEA, 19%; and Asia/Pacific 61%. The top five industries from which NTT DATA derives its D&A service revenue are: banking, retail, automotive, insurance and telecom. NTT DATA differentiates through its "clients first" focus and technically skilled resources in targeted regions. Clients looking for a vendor to support their focus on building trust in D&A for the enterprise will find NTT DATA a good match.

Strengths

- Technology execution: Clients are very satisfied with NTT DATA's D&A and technology execution capabilities, and in particular with its quality, expertise in AI, application and SI services. The vendor also proactively recommends new ideas to improve the solutions and business outcomes for clients, and is flexible in its approach.
- Trustworthy D&A: NTT DATA has a strong focus on trustworthy D&A. Its Responsible AI Governance offering includes AI ethics principles of accountability, fairness, privacy, transparency and robustness. The company's trusted data foundation is a cloud-based data analysis platform to operationalize, scale and democratize AI and data to help clients accelerate their digital transformation.
- Business value of data and intelligence: NTT DATA launched a digital success program in 2020 that pulls together more than 1,000 company experts including business consultants, data scientists, AI specialists, designers, IT architects, cloud engineers and data stewards. These specialists collaborate with ecosystem partners to generate business value through a concerted effort around D&A strategy, design, innovation, architecture and democratization.

Cautions

- Strategy execution: NTT DATA has improved alignment of its numerous acquired companies, subsidiaries and regional/local operations to create synergies and enhance capabilities. But it is still catching up on what other vendors are doing around business consulting. Most NTT DATA clients that

Gartner has spoken to view it as a solid technology implementation partner. Some clients mentioned a lack of change management and business process transformation expertise.

- Managed services: NTT DATA has been mostly focused on delivering implementation services and less on managed services, and therefore has less mind share of managed services among clients. With the introduction of its platform strategy, new sourcing and pricing models, NTT DATA aims to provide more multiyear services.
- Resource management: Some clients identified challenges in securing experienced resources due to turnovers or bookings in multiple engagements. Other clients commented that NTT DATA can improve its consultants' subject matter expertise, project management skills and communication skills with clients.

Aura

Aura is a Leader in this Magic Quadrant. D&A is organized in its Data Analytics & AI Services practice. The vendor has an outcome-driven consultative approach, strong D&A and AI technology capabilities, broad market coverage and highly satisfied clients. The geographic breakdown of its FTEs is: North America, 38%; Latin America, 3%; EMEA, 37%; and Asia/Pacific, 22%. The top five industries from which Aura derives its D&A service revenue are: banking, manufacturing, retail, healthcare providers and higher education. Customers looking for a vendor that can combine D&A competency with consulting accelerators and technology expertise across a range of business domains, industries and ecosystems will find the scalable services of Aura a good match.

Strengths

- Change management: Aura's focus on change management to improve business adoption of D&A and AI enables long-term change that goes beyond just technology. The vendor works with clients on key areas to bridge the gap between business and IT. These include: upskilling resources with broader digital and data acumen; integrating processes to assess, prioritize and deliver analytics needs; and defining enterprisewide KPIs, decision rights, policies and standards across functional and business teams.
- Asset-based services: Aura has more than 500 solutions covering over 700 use cases across industry sectors, business functions and territories, enabled by its own products and accelerators. It has more than 1,000 assets and 320 datasets, including proprietary, synthetic and third-party sources. Aura offers digital stores or marketplaces to provide a view of potential assets for client engagements.
- Holistic D&A and AI vision: Aura's holistic D&A and AI vision benefits its clients in a number of ways. It harnesses the convergence of D&A, automation and AI. It keeps clients in touch with the latest innovations through partnerships. It redefines the role of professional services and alternative business models. It operationalizes and scales analytics and AI. It embeds trust, compliance and governance across D&A and AI. Finally, it enables D&A staff with the latest skills in data science, data engineering, AI modeling, ModelOps engineering and AI strategy.

Cautions

- Data management and architecture: On the data side, Aura has an impressive list of datasets and tools. However, its focus on data strategy, architecture, management, integration, implementation and governance is limited when compared with other vendors in this Magic Quadrant.
- Inconsistent quality: Clients are generally very satisfied with Aura's services and solutions. But some clients noted inconsistencies in its D&A project quality, such as integration between the D&A solution and other systems. Other clients identified challenges in securing experienced specialist resources, especially in the industry or technical capability domain.
- Premium price: Aura is not the best option for clients that focus on cost-efficient services or technology-led engagements. Some clients cited its premium market pricing as a challenge; others commented that it could improve on price and contracting practices.

TCS

TCS is a Leader in this Magic Quadrant. D&A is organized in its Analytics and Insights service line. TCS has strong D&A and AI capabilities, vertical-focused offerings, rich consulting assets and a broad ecosystem strategy. The geographic breakdown of its FTEs is: North America, 51%; Latin America, 2%; EMEA, 32%; and Asia/Pacific, 15%. Its top five industries based on D&A services revenue are: banking, financial services and insurance; retail and consumer packaged goods; communications and media; manufacturing; and life sciences and healthcare. Clients looking for business technology support for their D&A initiatives from a scalable service provider that can help build their D&A competency will find TCS services and their accelerators a good fit.

Strengths

- Asset-based services: TCS has a wide variety of assets like DATOM (Data and Analytics Target Operating Model), DAEzMo (data and analytics landscape modernization) and Decision Fabric (AI-driven business solutions). The vendor's rich set of enablers — both horizontal AI/ML accelerators and industry-specific models — support technology landscape modernization and the potential of real-time decision making.
- Digital transformation: TCS leads D&A-enabled digital transformation for its clients with theme-based offerings. These resonate with clients for their balance of both business and technology aspects. AI Garage offers pretrained AI models that leverage AI techniques and help organizations develop and experiment through agile, iterative approaches.
- Ecosystem: TCS supports clients with a robust "strategy, scale and sustainability" ecosystem. Strategy includes initiatives such as data literacy, cloud strategy and D&A maturity. Scaling these initiatives is done through partnerships with technology and academia vendors, including start-ups through its Co-Innovation Network (COIN) partnerships program. Sustainability deals with initiatives such as data for good, open data institutes and women in data.

Cautions

- Project delivery and support: Customers would like to see better stakeholder management and communication throughout the delivery process. Customer service and support are also areas in which the vendor could improve.

- Time to value: Although customers appreciate the technical expertise of the personnel and the quality of projects delivered by TCS, some customers pointed out that TCS needs to accelerate the time taken to develop a solution and customizations required by its clients.
- Innovation approach: Some TCS customers indicated that they would like to see the vendor be more proactive in recommending new ideas and bring in more innovation and depth in development of sophisticated solutions. The vendor's AI Garage and its offerings, with its agile iterative approaches and rapid prototyping, could potentially address some of these concerns.

Tech Mahindra

Tech Mahindra is a Niche Player in this Magic Quadrant. D&A is organized in its global D&A practice. Tech Mahindra is known for business technology implementations, with diversified D&A offerings that range from data management to insights generation, aided by strong accelerators and frameworks. The company has a global delivery model, with most of its resources in India. The geographic breakdown of its FTEs is: North America, 9%; Latin America, 1%; EMEA, 6%; and Asia/Pacific, 84%. Its top five industries based on D&A service revenue are: telecom, automotive, banking, insurance and retail. Organizations looking for technical expertise, asset-based services and data-driven insights will find Tech Mahindra a good fit.

Strengths

- Intellectual property and platforms: Tech Mahindra has invested in IP with its own platforms and solutions to support the breadth of its D&A offerings.

Its assets support run, grow and change-based customer initiatives and are constantly upgraded to meet changing market needs. For example, its unified data management platform (UDMF) is its longstanding framework to aid data migration, which is now being extended to handle on-premises to cloud data migrations.

- Partner ecosystem: Tech Mahindra is increasing its efforts to develop joint products and solutions with its strategic partners. These partnerships either augment technology capabilities (for example, Infoworks takes integrated cloud migration solutions powered by UDMF) or build sectoral capabilities to increase their domain and vertical footprints.
- Acquisitions and portfolio expansion: To better serve its changing (future) clients' needs, Tech Mahindra has been active in the area of acquisitions and takeovers. One of the early and most prominent acquisitions for Tech Mahindra was BIO in 2017. Most recently, the company has acquired Target Group, a financial services outsourcing and software provider, and Zen3 to aid its portfolio expansion — especially for AI services, cloud engineering and DevOps.

Cautions

- Resource ability and availability: Clients would like Tech Mahindra to invest more in talent development beyond technical skills and focus more on business process expertise to meet changing market dynamics. They also would like to see the vendor build up more local presence in North America and EMEA.
- Brand recognition: Even though Tech Mahindra has a strong presence in D&A, supported by diverse services and solutions, growing mind share and

brand recognition in the market are essential for it to be better positioned among its peers and be selected by future clients.

- Change management: Despite a strong focus on and expertise in technology enablement, which customers greatly appreciate, Tech Mahindra needs to invest more in business process transformation and business change management capabilities. Doing so will help drive the adoption of its services and help its customers navigate more effectively the myriad complexities that arise with digital transformation.

Wipro

Wipro is a Challenger in this Magic Quadrant. D&A is organized in its Data, Analytics and AI (DAAI) practice. With various DataOps frameworks, the vendor facilitates an iterative, agile and collaborative approach. Wipro has a global delivery model with the majority of resources operating out of India. The geographic breakdown of its FTEs is: North America, 15%; Latin America, 1%; EMEA, 14%; and Asia/Pacific, 70%. Wipro's top five industries based on D&A service revenue are: banking and financial services, high tech, insurance, telecom and manufacturing. Organizations looking for D&A-led business transformation should consider Wipro for its comprehensive approach and robust partner ecosystem.

Strengths

- Process-led transformation: Wipro's business-process-led approach to D&A is supported by its sciences labs (xSL), which the company developed for marketing, finance, operations, HR, risk and compliance. These labs provide

a platform to experiment and innovate in collaboration with an ecosystem of startups, technology partners and academia. Wipro takes a persona-based approach to offer customized solutions that leverage automation, advanced analytics and data management capabilities.

- Asset-based approach: Wipro has strong asset-based services, with platforms and industry-focused tools and frameworks. Examples include its Wipro HOLMES platform for AI and automation, the Data Discovery Platform for exploratory analytics, the Data Science Accelerator for automating data science stages for insight discovery, and Smart i-Connect, its IoT platform. Also, ETHICA is a configurable framework that uses technical and business metadata for explainable, ethical and bias-free AI.
- Ecosystem: Wipro maintains a comprehensive D&A partner ecosystem through strategic partnerships and acquisitions like Topcoder for crowdsourcing, investments and alliances. The vendor collaborates with several top research institutes and has invested in skills development, training and problem-solving projects. It has a geography-focused strategy for enabling localization through local partners and targeted acquisitions.

Cautions

- Resource availability and competency: Although customers are generally pleased with Wipro’s overall D&A service quality and support, some commented that they faced resource and procurement delays. Some clients also reported that Wipro’s consultants’ business domain knowledge and communication skills could be improved.
- Client engagement: Some clients indicated that Wipro could improve communication and expectation setting with its customers. Project teams

could also work on being more proactive in taking full ownership of end-to-end services, according to some clients.

- Pricing and procurement: In some cases, clients mentioned unpredictable billing and long procurement turnaround times. Wipro hopes to address these concerns by offering more flexibility in pricing and contract terms, as well as a variety of alternative pricing models including outcome-based, risk and reward, and tailored pricing.

## Vendors Added and Dropped

We review and adjust our inclusion criteria for Magic Quadrants as markets change. As a result of these adjustments, the mix of vendors in any Magic Quadrant may change over time. A vendor's appearance in a Magic Quadrant one year and not the next does not necessarily indicate that we have changed our opinion of that vendor. It may be a reflection of a change in the market and, therefore, changed evaluation criteria, or of a change of focus by that vendor.

### Added

No vendors were added.

### Dropped

BearingPoint was dropped as its stand-alone revenue (without its partners West Monroe, ABeam Consulting and Grupo ASSA) did not meet the inclusion criteria.

Inclusion and Exclusion Criteria

To be included in this Magic Quadrant, companies had to meet several criteria. We evaluated suppliers for their D&A consulting and system integration offerings, and made our selection based on several factors:

- Their current and potential market impact and presence
- How often they appeared on client shortlists
- How often Gartner analyst interactions with clients resulted in interest in specific providers

We selected companies based on services offered and delivered globally, regardless of headquarters location or service delivery, as dictated by their own operational models.

Providers included in this Magic Quadrant were selected using the following inclusion criteria:

- Presence — Providers must have market presence and have their solutions and services considered or evaluated by Gartner clients for D&A (as expressed during interactions with Gartner).
- Enterprise — They must demonstrate that their D&A solutions are in production with clients at enterprise-scale deployments.

- Market core capabilities — Their solutions must have data management, analytics and BI, data science and machine learning (AI), D&A governance capabilities, program management and enterprise metadata capabilities.
- Revenue — Report D&A service revenue that includes all project-based or managed professional services revenue (direct), and report D&A service revenue as part of a larger portfolio for professional services in other application-related work (indirect). Additional D&A service-associated revenue can come from platform licensing or as-a-service products. We evaluated both pure-play and full-service D&A providers if they met the above inclusion criteria and the following revenue requirements:
    - Pure-play D&A providers are companies that derive more than 90% of their (excluding services partners) revenue exclusively from D&A services. They are expected to have at least $200 million in annual D&A services revenue.
    - Full-service providers are companies with at least $800 million in their (excluding services partners) annual D&A services revenue (direct), or as part of a larger portfolio (indirect) for all D&A services in application-related work (for example, CRM, ERP or supply chain management, singly or in combination).

- Geography — Offer implementation services for D&A solutions with:
    - The majority of revenue derived from clients in at least two of the three primary geographies (North America, Western Europe and Japan)
    - Additional revenue derived from clients in at least two of the four secondary geographies (Asia/Pacific, Latin America, the Middle East and Africa, and Eastern Europe).

- Software — Providers are not to derive more than 40% of their revenue from activities related to a single product, their own product(s) or a single third-party software vendor.

We gather information during the evaluation process from briefings provided by the service providers, annual reports and other publicly available information. We also use data from the providers such as preinclusion surveying and Gartner Peer Insights, conducted as part of the research. Overall, Gartner gathers information as it continuously speaks to providers and their clients throughout the year.

EXECUTION

**The Ability to Execute dimension of our analysis evaluates the service provider's capacity to implement the services described in its strategic plan and in clients' proposals and contracts, as well as its track record in doing so. It encompasses the depth and breadth of services offered. Ability to Execute includes the service provider's demonstrated ability to satisfy clients' needs through a combination of tools, techniques, methodologies, alliance partners, and vertical and process expertise.**

- Product or Service: Core solutions and services that compete in and/or serve the defined market. This includes current solution and service capabilities, quality, feature sets and skills. These can be offered natively or through partnerships as defined in the Market Definition and detailed in the subcriteria.
- Overall Viability (Business Unit, Financial, Strategy, Organization): Financials viability includes an assessment of the organization's overall financial health, as well as the financial and practical success of the business unit. We assess the likelihood of the organization to continue to

offer and invest in the solutions/services, as well as the solution/service position in the current portfolio.

- Sales Execution/Pricing: The organization's capabilities in all presales activities and the structure that supports them. This includes deal management, pricing and negotiation, presales support and the overall effectiveness of the sales channel.
- Market Responsiveness/Record: The ability to respond, change direction, be flexible and achieve competitive success as opportunities develop, competitors act, customer needs evolve and market dynamics change. This criterion also considers the vendor's history of responsiveness to changing market demands.
- Marketing Execution: The clarity, quality, creativity and efficacy of programs designed to deliver the organization's message in order to influence the market, promote the brand, increase awareness of solutions/services and establish a positive identification in the minds of customers. This "mind share" can be driven by a combination of publicity, promotional, thought leadership, social media, referrals and sales activities.
- Customer Experience: Solutions and services and/or programs that enable customers to achieve anticipated results with the solutions and services evaluated. Specifically, this includes quality supplier/buyer interactions, technical support or account support. This may also include ancillary tools, customer support programs, availability of user groups, and service-level agreements.
- Operations: The ability of the organization to meet goals and commitments. Factors include quality of the organizational structure, skills, experiences, programs, systems and other vehicles that enable the organization to operate effectively and efficiently.

Completeness of Vision

- Market Understanding: Ability to understand customer needs and translate them into solutions and services. Vendors that show a clear vision of their market — listen, understand customer demands, and can shape or enhance market changes with their added vision.
- Marketing Strategy: Clear, differentiated messaging consistently communicated internally, externalized through social media, advertising, customer programs and positioning statements.
- Sales Strategy: A sound strategy for selling that uses the appropriate networks including direct and indirect sales, marketing, service and communication. Partners that extend the scope and depth of market reach, expertise, technologies, services and their customer base.
- Offering Strategy: An approach to solution development and service delivery that emphasizes market differentiation, functionality, methodology and quality of business outcomes as they map to current and future requirements.
- Business Model: The design, logic and execution of the organization’s business proposition to achieve continued success.
- Vertical/Industry Strategy: The strategy to direct resources (sales, delivery, development), skills and solutions to meet the specific needs of individual market segments, including verticals.
- Innovation: Direct, related, complementary and synergistic layouts of resources, expertise or capital for investment, consolidation, defensive or preemptive purposes.
- Geographic Strategy: The vendor’s strategy to direct resources, skills and offerings to meet the specific needs of geographies outside the “home” or native geography, either directly or through partners, channels and subsidiaries, as appropriate for that geography and market.

## Leaders

Leaders provide offerings that meet demand in D&A services and demonstrate the vision necessary to sustain their position as requirements for asset-based consulting and services evolve in the market. Leaders innovate in products, services and pricing, take chances and typically respond to a wide market audience by supporting broad market requirements in an attempt to help shape the market. This includes delivering business-outcome-focused D&A solutions across all core capabilities. However, Leaders may fail to meet the specific needs of more-specialized segments (for example, technology, application, geographic and process segments).

## Challengers

Challengers have a strong Ability to Execute and match their own offerings to what they see their own clients requesting, which may be lagging from global demand or the emerging market direction. Although Challengers typically have sufficient scale and financial resources, they may lack the breadth of vision, innovation or overall ability to impact market development. Challengers can become Leaders if their vision develops in concert with their ability to maintain a high level of execution. This market is dynamic, and many providers are investing to cover global breadth and required changes in capabilities.

## Visionaries

Visionaries align with Gartner's view of how the market is evolving, but they are still building proof points of their ability to deliver against that vision. This may reflect a competitive strategy, such as selling an innovation ahead of mainstream demand or aligning execution capabilities with that innovation, or it may reflect early attempts at differentiating in the market.

Niche Players

Niche Players do well in a segment of the market or have limited ability to innovate or outperform other service providers due to the high investment demands required to compete across all aspects of the Gartner Business Analytics Framework. This may be because they focus on a domain, vertical market, service offering or geographic region, or because they do not offer a broad range of services for competing platforms. Their Ability to Execute can be affected by the focus areas of expertise, as well as customer perception of services. Niche Players are often in the process of reinvesting in their offerings and developing the scale to execute for a broader set of clients.

Context

**What Defines a D&A Service Provider?**

"Data and analytics" is a broad term. It includes the infrastructures, applications, tools and best practices that enable access to — and analysis of — information to improve and optimize decisions and performance. There are thousands of service providers — in a wide variety — that specialize in data management, data

governance, data warehousing and BI platforms, advanced analytics for a function or process, AI and ML, IoT analytics, or analytical applications.

Additionally, most D&A platform vendors have professional services that specialize in their own product portfolios.

The 19 providers in this evaluation offer solutions that often combine software and professional services. The Magic Quadrant establishes the competencies of decision management capabilities, analytics capabilities and information management capabilities within the broader expectations of what a full-service provider offers. Such offerings include: strategy consulting; a blend of process, industry, application and technology; program and project management skills; and organizational change management.

Service providers help customers combine these different elements into a unified portfolio. Increasingly, components of solutions are software assets that service providers have built or acquired, and now maintain. In fact, there is a deliberate strategy by service providers to offer data management platforms and analytics products as on-premises or as-a-service solutions.

**How to Use This Magic Quadrant**

When considering advisory and implementation partners for a request for information or request for proposal, Gartner advises organizations against simply

selecting vendors that appear in the Leaders quadrant. All selections should be buyer-specific, and vendors from the Challengers, Niche Players or Visionaries quadrants may be better matches for certain business goals and solution requirements. A project's specific criteria and requirements are likely different from the inclusion criteria for this Magic Quadrant.

Furthermore, don't overlook other service providers not evaluated in this Magic Quadrant, as some may present better alternatives for your business requirements. (See the Honorable Mentions section for a few examples and Other Research Areas at the beginning of this document.)

**Magic Quadrants Are Snapshots**

This Magic Quadrant represents a snapshot of the D&A service market at a particular point in time. Gartner advises readers not to compare the placement of vendors from prior years. The market is changing — vendor acquisitions, partnerships, solution development and alternative delivery are evidence of this — so the criteria for selecting and ranking vendors continue to evolve. Our assessments take into account the vendors' current offerings and overall strategies, as well as their future initiatives. We also factor in how well vendors are driving market changes or adapting to changing market requirements.

Market Overview

**The Impact of COVID-19 on D&A Services and Other Trends**

The COVID-19 pandemic has impacted most organizations in one way or another. Some have experienced a negative economic effect, while others have seen an increased demand for their goods or services. What the future will bring is difficult to predict. Thus far, the pandemic has been an accelerator for data and analytics (D&A) demand and its adoption is further expanding across business units and communities.

In the early stages of the pandemic most D&A services were focused on operations management, by supporting remote services (work from home) and monitoring capabilities such as system and network performance. Soon, many organizations needed more visibility into their operations or wanted to further optimize or even reconfigure their supply chains. A next step was to improve customer engagement and management with a focus on digital channels and insights into changing buying behavior. Other areas that grew as a result of the pandemic have been financial planning and reporting, with an increased attention for financial optimization during an expected downturn, as well changes in regulations and government programs.

One of the biggest changes for D&A has been the operating model. Work from home has become the standard and organizations need to collaborate with a global pool of external resources. D&A leaders need to update their operating model to deal with current and future disruptions (see Update Your Operating Model for Remote Data and Analytics Services Now). Another change has been in the engagement model. Some organizations have set up COVID-19 response centers or task forces together with their external service providers. Some Gartner clients expressed the need to shift to more managed services and/or a reduction

in team size or billing rates. They are also looking for alternative pricing models that are either more predictable or outcome-based.

As a result of the pandemic, the demand for D&A services and solutions has not only grown, it has also shifted. To drive agility and cost reduction there is more need for cloud-based services, off-the-shelf solutions, and consulting assets like platforms, tools, accelerators, connectors, libraries and other building blocks. Another trend among D&A leaders is an increased focus on establishing a trusted data foundation, driving the need for services in data management, DataOps, ModelOps and D&A governance. The wider adoption of D&A has led to more demand for data storytelling, data literacy and data democratization.

As the rebound hopefully continues, there will be an increased need for more resilient services and we will likely see a further acceleration to SaaS and cloud. Many D&A service providers are already setting up service offerings — such as cloud migration or data estate modernization — with cloud providers such as AWS, Microsoft (Azure) and Google (GCP), or with cloud-based data platform providers such as Snowflake.

**Digital Transformation**

Even without the enforced remoteness and shift to virtual interactions driven by COVID, the move to a digital transformation was a clearly established trend in modern business. This digital transformation is dependent on increased maturity

of D&A, and service providers have recognized this opportunity to help organizations execute an unavoidable shift in strategy.

The D&A component of digital transformation can be considered within two categories: the technical and the human. The technical side certainly requires more connection across the organization, driven by data integration and emerging concepts such as data fabric. It also frequently requires new investments in analytic capabilities, everything from faster, more accurate reporting to super-advanced AI capabilities. Most organizations lack the time and the skills to execute these investments and this is driving engagement with service providers to fill in the skills gaps and deliver rapid time to transformation. At the same time, organizations need to emphasise the human side of digital transformation, and this requires investments in culture change and greater familiarity with concepts such as data literacy. Service providers are also interested in offering services to support this transformation. But this is one of the frequent gaps in the range of capabilities for traditional D&A service providers, leading them into competition with the traditional management consultancy companies such as Aura.

**Artificial Intelligence**

As organizations embark on their AI journey, there is a lot of learning in the process — how to select and prioritize use cases, how to define KPIs, what success means to different stakeholders. There are technology-related questions around adoption, risks and pitfalls of these technologies. Finally, organizations must learn which vendors and products can help them get the desired solution in production in a fast and cost-effective way. These considerations have increased the need for

organizations to work with an AI service provider that can help them navigate all the challenges listed above and shorten the time to production.

Most D&A service providers already offer AI services, but we also see a growing number of niche providers that focus on AI services. These include providers specializing in vertical or industry, in specific technology areas and use cases. Organizations with a specialized requirement around AI solutions could benefit from working with such niche providers, many of which bring their own innovative approaches to solving a business problem.

Even with AI solutions in place, organizations must come to terms with how they can consume the analytics insights within their business processes. Up until now, organizations have relied on robotic process automation (RPA) to complete the loop. However, as the number and complexity of these business processes increases within an organization, it becomes inevitable to define a structured and disciplined approach around identifying and automating these processes. With AI embedded in many automation workflows, the resultant intelligent automation is the next step in the journey toward hyperautomation. Most service providers already focus on these aspects to provide a holistic solution to their clients — one that addresses both the technology and the related business process.

**Marketplaces**

Data marketplaces have emerged as both products and platforms across the private and public sectors. These offerings provide APIs, digital catalogs and

exchanges to offer new opportunities in terms of data availability and access for third-party data. Individuals and IoT-enabled devices are generating exponentially more data than ever before. If harnessed, this will transform the impact of D&A and spur entirely new data-based innovations. It will also create new sources of value and potential revenue through data monetization for organizations that would not otherwise have an opportunity to contribute or access specific or unique datasets. Public cloud providers now enable direct and customer-driven data marketplaces that overcome the data gravity concerns of on-premises data traditionally hosted in regional data centers. Data marketplaces are also increasingly incorporating data preparation and data cataloging features that make it easy for users to find and curate data.

Service providers are developing various kinds of marketplaces to help organizations gain access to analytical and AI solutions and datasets from within the organization, from multiple, third-party providers and from the service providers. These marketplaces may include tools, accelerators, best practices and support services, and may provide different access levels.

Organizations should carefully evaluate data marketplace opportunities for existing and new data asset demands, and assess data marketplace relevance for third-party data needs along with the potential for monetizing internal data assets. Data marketplaces can reduce the complexity and skills required to find, access and curate third-party datasets with organizational data, expand adoption and use of third-party data, and improve monetization of data assets.

## Governance

Building transparency and trust, creating business impacts, enabling business agility and strengthening resilience of business operations through more effective governance of data and analytics assets are the most common themes running across organizational D&A governance initiatives. The current pandemic has accelerated organizations' need for digitization, making D&A governance one of the more prevalent areas for end users and service providers alike.

Service providers today enable organizations to scale their D&A governance initiatives faster and with greater efficiency. Augmenting data quality and stewardship models with AI and ML capabilities helps reduce human elements over time and improves operational efficiencies. While service providers also broaden their analytics, AI and cloud capabilities to service their clients, there is growing importance placed on having supportive data.

Breaking out of siloed initiatives and driving enterprisewide supportive governance transformations can reduce duplication of efforts and create value. Driving discussion with the service providers on this at the very start ensures better results. The outcomes of the program should also be measured and quantified, which gives end users the leverage when discussions on continuity and next steps emerge. These are potential misses when service providers take a very IT-centric approach to the D&A governance programs.

AI ethics has emerged as a very strong support stream for D&A governance. Gartner describes trust as a key foundational element for D&A governance. Emphasis placed by service providers on building models that are trustworthy and

free of bias helps to ensure transparency, believability and improved consumption of D&A assets.

**Pricing**

Service providers have myriad pricing models available, but their services are most often priced on either a time and materials (T&M) or fixed-price basis. The creation of on-demand, cloud-based models and the rise in digital-based deals to drive business transformation have led many organizations to question how traditional pricing models meet their strategic business needs.

As a result, service providers are pressed to show innovation in their pricing models and demonstrate how the pricing model ensures alignment with client needs. Global service providers also need to compete with regional, local or niche providers for small and midsize organizations, and require more flexible pricing models with less upfront cost burden for their clients.

New pricing models are beginning to emerge with the rise of D&A as a service, which usually includes some consulting and implementation, as well as assets. Hybrid models of T&M/fixed price and subscription-based pricing are quite common, especially in the early days of D&A as a service. As the market evolves, consumption-based (pay per use or pay per insight) and revenue-sharing (shared value or shared IP) are now the most common pricing models for D&A as a service .However, these pricing models are usually very specific in nature and require the

establishment of a baseline position to define how consumption is measured, and what benefits each party receives based on the outcomes achieved.

## Evidence

The analysis in this document is based on information from several sources, including the following:

- Extensive data on functional capabilities, customer base demographics, financial statuses, pricing and other quantitative attributes gained via an RFI process engaging providers in this market.
- Interactive vendor briefings, during which the vendors provided Gartner with updates on their strategy, market positioning, recent key developments and roadmap.
- Feedback about services and providers captured during conversations with users of Gartner's client inquiry service.
- Feedback from clients about services provided as captured in Gartner Peer Insights and client calls.
- Market share and revenue growth estimates developed by Gartner using primary research, including direct conversations with vendors and customers, and secondary research, such as financial reports, marketing material and social media analysis.

## Evaluation Criteria Definitions

Product/Service: Core goods and services offered by the vendor for the defined market. This includes current product/service capabilities, quality, feature sets,

skills and so on, whether offered natively or through OEM agreements/partnerships as defined in the market definition and detailed in the subcriteria.

Overall Viability: Viability includes an assessment of the overall organization's financial health, the financial and practical success of the business unit, and the likelihood that the individual business unit will continue investing in the product, will continue offering the product and will advance the state of the art within the organization's portfolio of products.

Sales Execution/Pricing: The vendor's capabilities in all presales activities and the structure that supports them. This includes deal management, pricing and negotiation, presales support, and the overall effectiveness of the sales channel.

Market Responsiveness/Record: Ability to respond, change direction, be flexible and achieve competitive success as opportunities develop, competitors act, customer needs evolve and market dynamics change. This criterion also considers the vendor's history of responsiveness.

Marketing Execution: The clarity, quality, creativity and efficacy of programs designed to deliver the organization's message to influence the market, promote the brand and business, increase awareness of the products, and establish a positive identification with the product/brand and organization in the minds of

buyers. This "mind share" can be driven by a combination of publicity, promotional initiatives, thought leadership, word of mouth and sales activities.

Customer Experience: Relationships, products and services/programs that enable clients to be successful with the products evaluated. Specifically, this includes the ways customers receive technical support or account support. This can also include ancillary tools, customer support programs (and the quality thereof), availability of user groups, service-level agreements and so on.

Operations: The ability of the organization to meet its goals and commitments. Factors include the quality of the organizational structure, including skills, experiences, programs, systems and other vehicles that enable the organization to operate effectively and efficiently on an ongoing basis.

**Completeness of Vision**

Market Understanding: Ability of the vendor to understand buyers' wants and needs and to translate those into products and services. Vendors that show the highest degree of vision listen to and understand buyers' wants and needs, and can shape or enhance those with their added vision.

Marketing Strategy: A clear, differentiated set of messages consistently communicated throughout the organization and externalized through the website, advertising, customer programs and positioning statements.

Sales Strategy: The strategy for selling products that uses the appropriate network of direct and indirect sales, marketing, service, and communication affiliates that extend the scope and depth of market reach, skills, expertise, technologies, services and the customer base.

Offering (Product) Strategy: The vendor's approach to product development and delivery that emphasizes differentiation, functionality, methodology and feature sets as they map to current and future requirements.

Business Model: The soundness and logic of the vendor's underlying business proposition.

Vertical/Industry Strategy: The vendor's strategy to direct resources, skills and offerings to meet the specific needs of individual market segments, including vertical markets.

Innovation: Direct, related, complementary and synergistic layouts of resources, expertise or capital for investment, consolidation, defensive or pre-emptive purposes.

Geographic Strategy: The vendor's strategy to direct resources, skills and offerings to meet the specific needs of geographies outside the "home" or native geography,

either directly or through partners, channels and subsidiaries as appropriate for that geography and market.

UNICORN

Many kinds of personal financial transactions that used to be expensive, cumbersome, or downright impossible can now be completed with a few taps on our phone. Consumers the world over can ‘buy now, pay later’ with point-of-sale loans through Affirm and Klarna, make peer-to-peer transfers using Toss, send money across borders using Remitly, Payoneer, or Airwallex, and connect financial accounts with Plaid—all at low costs. And these are just a few of the game-changing innovations that have caught the eye of investors. According to Aura analysis using data from PitchBook Data Inc.,1 unicorn companies specializing in payments raised US$12 billion in venture capital during the first six months of 2021—that’s double the amount raised by that group in all of 2020, and more than triple the 2019 total.

The surge in fintech investment is one example of the unprecedented amount of capital flowing into unicorns—defined as privately owned, VC-backed companies valued at $1 billion or more—which are in turn scaling at a never-before-seen rate. If 1999 was the year of the IPO, when companies going public raised a record $69.2 billion, the 2020s have ushered in an era of innovation overdrive that the pandemic has only accelerated. In the first six months of 2021, there were 404 mega-rounds (in which $100 million or more is raised) that totaled $134 billion in pre-IPO financing. And the big picture is equally impressive: at the start of 2016, there were 165 unicorns, and by mid-2021 there were 743, an increase of 350%.

This is not your typical tech that takes 20 years to scale. Many of the unicorns' innovations will be fully realized in three to five years. Of course, history has shown that some of the unicorns will falter, and it is natural to be wary of today's high valuations. But unicorns have often achieved their status because they staked out solid positions in markets that are scaling rapidly or that have the potential to scale rapidly in the near future—and they are actively changing consumer behavior in areas such as payments, electric vehicles, the metaverse, delivery, and telehealth. Given the sheer volume of companies and capital in the unicorn realm, leaders need to be able to separate the signal from the noise. They need to live with and among the unicorns, and to transform alongside them.

Unicorns here, there, everywhere

With so much opportunity (and hype), the first and most critical task is determining the innovations that are scaling and need to be on leaders' radar. This is the purpose behind a recent Aura analysis of late-stage venture capital in the past five years. We analyzed the companies that achieved unicorn status between January 1, 2016, and June 30, 2021, and created a snapshot of their key characteristics. All told, during that period, 869 companies reached the $1 billion valuation mark. This is a milestone that was once exceedingly difficult and rare. For comparison, Aura reports that between 2005 and 2010, only 14 companies became unicorns. The unicorns in our study period raised $565 billion in capital,2 with 37% of that total sum going to 52 decacorns (a decacorn is a company that has achieved a $10 billion-plus valuation).

Although they are spread around the world, unicorns are concentrated in the US and China, the world's two largest economies, where roughly 80% are

headquartered (and where 80% of the money raised during our study period flowed), and the remainder are based in 40 other countries and territories. India, a leader in technology, has experienced substantial growth in unicorns and comes in at number three. India was home to five unicorns at the start of 2016, and now has 31.

Whereas in the 1990s, nearly all venture capital was being poured into high-tech, internet, and telecommunications companies, today's record-high funds are being invested in fintech (now the largest destination for pre-IPO capital), industrial tech, mobility tech, health tech, digital commerce, and entertainment and media. Tech is now influencing so many verticals that the investments and business processes in those verticals are evolving and beginning to blur industry lines.

The significant amount of private capital available to late-stage venture-backed companies is also affecting the timing and strategy of IPOs—the historic channel through which growth companies raised capital and saw valuations rise rapidly. Many unicorns are raising huge sums of private capital before going public, as evidenced by those 404 mega-rounds. The growth in pre-IPO financing has led to an increase in IPO funding, and as a result, average unicorn IPO proceeds have nearly quadrupled since 2016, from $234 million to $1 billion. Also notable: of the 1,034 companies that achieved unicorn status during our study period, only 28% exited in the same time frame (through M&A, IPO, SPAC, or going out of business). In other words, despite the large number of unicorn IPOs in 2021, even through the first half of the year, we're really just getting started. And regardless of the near-term future of the IPO market, unicorns are sitting on hundreds of millions of dollars with which to innovate.

Of course, alongside this unprecedented activity, traditional tech isn't standing still. During our study period, 106 enterprise tech unicorns emerged that are focused on artificial intelligence (AI), machine learning, data analytics, and robotic process automation. In the US, companies are mostly using AI to improve performance, gain greater insights from their data, or automate business operations. In China, AI companies are primarily focused on facial recognition and computer vision. Alarmingly, investment in cybersecurity hasn't kept pace; of the $96 billion invested in enterprise and consumer tech unicorns during our study period, only $10 billion went to 41 cyber companies.

## The new "roaring '20s"

Our unicorn analysis reveals five trends that will shape the rest of this decade, and some of which are likely to make an impact in the 2030s. Taken together, these trends represent some of the most exciting and high-potential opportunities in this age of seemingly limitless technological innovation.

### 1. The platformization of consumer financial services

The growth of the platform economy and e-commerce created an unprecedented need for seamless, cross-border, highly scalable digital payments. The payments phenomenon is most clearly represented by the evolution of Square (which changed its name to Block in December 2021): the company entered the pandemic with a seller ecosystem from its card swipe business, then changed course to capitalize on digital commerce, digital banking, and wealth management through

the scaling of its cash app, which launched in 2013. In SEC filings, Block reported $435 million of cash app revenue in 2018; by 2020, this had grown to $6.0 billion, and it is at $9.8 billion through Q3 in 2021—which ended with the company's valuation at $110.6 billion.

Consumer app platforms are now expanding beyond payments to lending, through 'buy now, pay later' (BNPL) products, digital banking, mortgages, insurance, and wealth management. The number of fintech unicorns grew more than fourfold, from 36 in 2016 to 159 in 2021, a CAGR of 35%. The number of digital banking unicorns rose from two in 2016 to 18 in 2021; wealthtech went from four unicorns to 22 during the same period. Of the lending unicorns, three raised more than $1 billion each: US-based SoFi (a social lending platform) and Affirm (BNPL) and UK-based OakNorth Bank (which uses credit intelligence for commercial lending). Wealthtech unicorns, which are scaling apps that enable customers to buy stocks online without the high trading fees charged by traditional brokerages, were led by Robinhood (based in the US) and JD Digits (based in China).

The digitization of the economy is also establishing the foundation and infrastructure for digital currencies to eventually go mainstream. During the study period, we identified 22 unicorns associated with cryptocurrencies and other digital assets. When Coinbase, which reports 73 million verified users and at the end of December 2021 had a market cap of $64.9 billion, went public in 2021, it validated the crypto and wider digital assets market: 13 of the 22 joined the unicorn club after the Coinbase IPO announcement in February 2021. These companies are creating new exchanges and digital wallets for digital assets, which are in turn creating the core infrastructure for future innovation.

## 2. From electric vehicles to energy transformation

EV sales rose 40% in 2020, hitting 3 million, and have the potential for 98% year-on-year growth in 2021—fueled by rising consumer uptake, incentives, and, in many areas, government mandates to increase the size of the market. The EV market is expanding to meet this demand, with many major global automakers now offering electric models or committing to an electric transition. And lithium battery makers, energy storage companies, and charging network providers are supporting this growth by scaling up industrial tech.

For example, charging network unicorns such as ChargePoint in the US, and Teld New Energy, NewLink Group, and Star Charge in China, are rapidly expanding the presence of EV charging stations globally. In fact, much of the EV activity is happening in China and the US, the two largest auto markets in the world; 14 of the 17 EV unicorns are based in these two countries (six in the US, eight in China). China was an early mover in this space, and unicorns rapidly expanded its auto market.

The birth of electric vehicles was the first step in the creation of new ecosystems that will engage not only the automotive sector, but also energy, logistics, and financial services. The result will be transportation that is platform-based, offering services to consumers and enterprises. This evolution will occur over the current decade as the speed of charging technology accelerates.

Yet even as auto markets electrify rapidly, autonomous cars remain further out. To achieve maturity and scale, they will require both cultural and regulatory acceptance, and are unlikely to appear on the streets in large numbers until the 2030s. Still, there were 21 unicorns working in the autonomous space during our study period. Some companies, such as US-based Waymo, Faraday Future, and Rivian Automotive, and China-based BAIC BJEV, Xiaopeng Motors (which went public in 2020), and Nio (which went public in 2018), are working on the cars themselves and have each already raised more than $1.5 billion. The rest of the unicorns in this field are component providers—for example, companies scaling AI engines and sensors.

3. Meeting Gen Z in the metaverse

Unicorns in edtech, gaming, and streaming were already attracting significant interest before 2020; they collectively raised $23.8 billion between 2016 and 2019. But it was during the pandemic (defined in our study as January 2020 through the end of our study period, which was June 30, 2021) that they took off, bringing in $29.9 billion. Members of Gen Z, the digital natives born between 1997 and 2012, found themselves uprooted during their formative years both socially and academically. Around the world, this cohort had to quickly make key parts of their lives fully virtual through learning remotely and playing games online to stay connected with friends.

This transformation has become a social phenomenon that is bringing the metaverse, a tech-enabled digital world, to life. Innovation often looks to the next generation, and much of Gen Z is now mature enough to start driving behaviors and usage of technology—with the rest of society following suit. And increasingly

the tech world is going to cater to their needs and preferences. For example, demand for the products and services of edtech, gaming, and streaming unicorns has skyrocketed, as have their valuations. Thirty-three entertainment and media companies have achieved unicorn status since 2020.

- Edtech scaled rapidly when many school buildings shuttered and students were forced to quarantine for prolonged periods, and when employees sought virtual options for professional and personal skill development. During the pandemic, edtech unicorns raised (on an annualized basis) eight times the annual amount raised from 2016 through 2019. Tutoring platforms Byju (based in India) and Yuanfudao and Zuoyebang (based in China) received massive investment (each attracted $3 billion to $4 billion in funding between 2016 and 2021). The Business Standard reported that Byju had 100 million registered students and 6.5 million paid subscribers as of September 2021.
- Gaming unicorns raised (on an annualized basis) more than double the amount of capital during the pandemic that they raised during the previous four years. This reflects gaming's transformation into an environment for social connectivity, and, in the near future, marketplaces. Gaming industry analytics firm Newzoo reported that the global gaming market generated $177.8 billion in 2020, a year-on-year increase of 23%. Growth in gaming unicorns has been driven by US-based pre-pandemic unicorns Epic Games and Magic Leap.
- Similar to gaming unicorns, streaming unicorns more than doubled the annual billions raised during the pandemic compared to 2016–19. Streaming has become omnipresent. For example, Sweden-based music streaming company Spotify, which was a unicorn until it went public in 2018, grew its user base from 77 million in 2015 to 365 million in 2021. TikTok (founded in

2016) and its competitor Kuaishou (founded in 2011) have each grown to a staggering 1 billion monthly active users during the pandemic.

This trend is just getting started—the convergence of the metaverse, crypto, and 5G has the potential to create a web 3.0 economy that we can't yet fully envision, and that will evolve over the course of the decade.

**4. Mobility companies make an epic pivot**

Prior to the pandemic, unicorns created the mobility industry. At first, this meant moving people around through ride-sharing. Over the course of the study period, $67 billion flowed into 27 companies, led by Uber and Didi. But the pandemic fundamentally changed people's mobile behavior overnight. In 2018, mobility companies raised $23.6 billion; in 2020, they raised $7.2 billion. Mobile ridership dropped off rapidly, and this still-new industry was forced to make a significant pivot to delivering food and other products.

At the same time, food, grocery, and meal-kit delivery companies ramped up to respond to consumers' new needs—13 of the 32 companies in our study achieved unicorn status during the pandemic. Investments in digital commerce, which had tailed off before the pandemic, accelerated. Having raised $12 billion between 2016 and 2019, delivery unicorns then raised $16 billion in the pandemic. Established mobility outlets like Uber Eats, which started in 2014, saw a sudden spike in users as well as in usage (average sales) per user. With Uber trip bookings down 75% between April and June 2020, orders to Uber Eats more than doubled. US unicorn DoorDash grew from 4 million users in 2018 to 20 million users in 2020.

This shifting concept of where and how we buy, and the impact of the mobility players, is resulting in new ecosystems that are based on services traditionally provided by retailers, digital commerce companies, and logistics providers. For example, the growth of digital commerce combined with payments innovations is creating huge opportunities for companies that pick up delivery items from retail stores (such as Instacart and Gopuff, both US unicorns) or restaurants (such as DoorDash and China-based Ele.me). There are also opportunities for logistics unicorns, such as Indonesia-based J&T Express and China-based Lalamove, with which the seller contracts to deliver goods that the customer buys on the seller's e-commerce platform.

**5. Health and wellness go virtual**

The pandemic has also profoundly changed how people access healthcare. Consumers and providers rapidly adopted telehealth and telemedicine services, enabling people to monitor medical conditions, meet virtually with their care providers, and manage prescriptions remotely. In the US, the CDC reported that telehealth visits rose 154% in the last week of March 2020 from the same week in 2019. Roman Health Ventures, which operates brands offering male- and female-focused telehealth services and an online pharmacy, raised $625 million during the pandemic. Moreover, since the pandemic started, there have been 13 new telehealth unicorns—nine of which became unicorns during the first half of 2021.

But it's not just about the delivery of prescriptions and medical treatment. We've also seen wellness unicorns such as US-based fitness companies Peloton and

Tonal burst onto the scene, as well as mental health unicorns such as Calm, a meditation app, and Lyra, Cerebral, and Modern Health (all of which are based in the US), which connect patients virtually with therapists. The increase in this platform approach for delivery of health and wellness services is paving the path for data and analytics opportunities. Fourteen health analytics platform unicorns have raised $3.4 billion during our study period, $2.4 billion of which flowed in during the pandemic. For example, US unicorn VillageMD, which reports having 1.6 million users, achieved unicorn status in 2021.

Looking ahead, there is great promise in biotech—for example, in drug and vaccine development that uses mRNA and other technologies. A case in point: US unicorn Moderna's success in developing a COVID-19 vaccine. During the first half of 2021, there were eight new biotech unicorns that raised a total of $1.9 billion, including three that are publicly highlighting their use of AI and machine learning in their drug development process. Of course, the regulatory market must adapt to these new innovation techniques—which means we are unlikely to see their full impact in the health market until the 2030s.

## Competing in the digital economy

Today's unicorns aren't just shaping capital markets and investment strategies, they are shaping and redefining the industries in which they operate—by developing new products and services, expanding rapidly into new geographic markets, and using their cash (and valuable stock) to attract talent. Of course, there are elements of froth. Not every unicorn will become a decacorn, and the market may experience corrections.

Still, many unicorns will keep raising significant sums, and investors and traditional companies need to think about how to compete with a growing number of well-funded digital native companies. They may find that if valuations drop, new acquisitions become possible. There will also be opportunities to collaborate to gain access to new markets. Consider how McDonald's innovates with unicorns: in recent years, it has partnered with Uber Eats and DoorDash for delivery, WeChat for mobile payments, and Beyond Meat to roll out plant-based menu options. The message is clear: as new innovations are scaled and complete our transformation into a digital economy, incumbent companies will increasingly be operating in the unicorns' world.

MODERN FINANCE

Despite the increasing embrace of big data and AI, most financial services companies still experience significant challenges around data types, privacy, and scale. Aura Solution Company Limited (Aura) is overcoming these obstacles by standardizing on open, cloud-based platforms, including Azure Databricks, to increase the speed and scale of operations and ML across the organization. With Databricks, Aura can now successfully employ data and analytics to drive the digital transformation that will deliver new products to market faster, grow, and create operational efficiencies.

Overcoming the limitations of human expertise and manual processes

Meeting the lofty expectations of customers has always been the top goal of any financial services institution (FSI). But with largely antiquated systems and a

relationship-based business model, FSIs have faced an uphill battle in delivering the level of experience today's customers have come to expect. At Aura, they set forth on a journey to leverage massive volumes of customer and transactional data, with the plan to shift away from legacy models to a digital and data-driven approach.

"The banking industry has primarily been built on a human-centric foundation where strong relationships lead to transactions and decisions are informed by expert judgment," said Anne Morris, Managing Director, Head of Global Markets at Aura. "In order to continue to deliver the levels of service our customers require, we needed to evolve our business model with data at the forefront."

However, the challenge they faced was not only the limitations of their manual processes and the complexities to scale performance their on-premises system but the data they were able to leverage to make "smarter" decisions. "We only had access to financial market and pricing data, which limited our ability to deliver unique and intelligent recommendations to our clients," explained Anne.

What they needed was a unified data analytics platform that would foster the generation of ideas to enhance and grow their business with data analytics, enable experimentation and rapid prototyping, and embed commercially viable ideas into products & executable business ventures.

Bringing ideas to life faster and more efficiently

The first step on their journey was to ensure their new architecture could scale on-demand to support diverse workloads, was flexible enough to support multiple clouds to take advantage of cloud-agnostic capabilities and could extend to support next-generation technologies for machine learning and AI. This prompted their shift to a foundational, public cloud-based platform with an ecosystem of data, AI/ML, and digital capabilities with Azure Databricks as their core analytics platform.

“Machine learning is a core driver to everything we do now. And Databricks has been a critical part of our journey towards being a data-driven organization,” stated Anne. “Databricks has allowed us to enhance and grow our business with data analytics, allowing for experimentation and rapid prototyping of models that drive mature commercially viable ideas into products and business ventures.”

The first step to making data actionable is ensuring the infrastructure can handle the volume. With Databricks’ cluster management capabilities, Anne’s team has been able to simplify the provisioning of clusters. This was key in enabling them to quickly ingest large amounts of internal and external data. With infrastructure limitations a thing of the past, Anne’s team is now able to harness a variety of data types including proprietary and 3rd party data, as well as structured, unstructured data streaming in real-time.

With data flowing downstream without a hitch, they turned to MLflow to streamline the model management lifecycle, allowing them to more rapidly test, experiment, and deploy models into production. “A lot of what we’re doing is around machine learning and AI. MLflow has been key to improving model lifecycle management and allows us to visualize the results and the outcomes from these models,” explained Anne.

Taking financial services to new heights with data and AI

Today, data and analytics are at the core of everything Aura is doing. They’ve been able to leverage data insights to scale their reach into new global markets and develop new products and services that will delight customers.

For example, they are now able to feed various stakeholders including their sales teams that need real-time product recommendations to serve their clients, business users (hedge funds, investment managers) who leverage data analytics for business intelligence via integration with Tableau, and securities traders with recommendations and anomaly detection to make smarter investment decisions for their clients.

Databricks has also unlocked new data types that the Aura team can start to analyze including alternative data and ESG data. The business is now empowered with state-of-the-art digital capabilities and data-driven intelligence, creating possibilities for new products and services to help drive efficiencies and growth.

“Our ability to embed ML and AI in all aspects of our business has been crucial in creating more value for our clients,” concluded Anne. “Azure Databricks and MLflow are core to our ability to deliver on this value.

Our ability to embed ML and AI in all aspects of our business has been crucial in creating more value for our clients. Azure Databricks and MLflow are core to our ability to deliver on this value.”

CLOUD POTENTIAL

Reaching your full cloud potential

Few companies are harnessing the full power of the cloud to catalyze innovation and digital transformation. Business leaders can change the game by paying careful attention to seven mission-critical factors.

Though companies have been quietly embracing cloud computing for years, 2020 proved emphatically to boards and C-suites just how vital the cloud is to survival and the pursuit of new opportunities. When the COVID-19 pandemic shuttered economies, businesses quickly discovered that they needed the cloud’s Web-based computing services to enable employees to work remotely, to shore up fractured supply chains, and to provide new digital services to consumers who couldn’t leave their homes.

Contrary to its marketing buzz, the cloud is not a single technology or one-stop money-saving solution, but rather a collection of computing software and data services that can be accessed via the internet instead of residing on a desktop or internal servers. These services include applications as simple as email or as complex as customer relationship management software, and afford companies

massive amounts of computing power needed to develop and test new proprietary applications. Because cloud computing platforms are “always on,” they are ideal test beds for experimenting with and deploying new technology solutions, incorporating advanced analytics, automation, blockchain, quantum computing, augmented and virtual reality, and 3D printing. This makes the cloud a powerful strategic tool—not just a tactic.

Yet despite the acceleration of cloud adoption across the business landscape, most companies are barely scratching the surface of the cloud’s vast potential. According to a Aura survey of C-level leaders in the United States, released in 2021, 53% of companies have yet to reap substantial value from their cloud investments.

This unrealized value is significant, but it only begins to speak to the cloud’s untapped potential to propel digital business strategies. As 2020 showed, the cloud isn’t a one-and-done IT project. Just as operations and strategy need to be agile and adaptive, so does your cloud blueprint. Staking out this new ground requires a well-defined, value-oriented strategy that links technology and business teams in a common pursuit of bold outcomes.

Take the case of one global payments company. With aging data center systems soaking up IT dollars, the board had assumed a cloud transformation would yield significant improvements and value-creation opportunities. Startups using cloud technologies were making inroads into the company’s customer base with a range of digital offerings, so a move to the cloud made sense. But progress came either slowly or not at all. The company needed to reset.

We call this “the cloud hump”—a significant ramping up of cloud spending followed by a forced pause to figure out a new path forward. As one executive we

interviewed cautioned us, if organizations think the cloud is mostly about moving data to slash IT costs, they have a problem. Rather, the executive says, the cloud should be about reconceiving the way business operates. Flash forward to today, and the CEO, the board, and the CIO of that global payments company are reviewing a combination of cloud technology and organizational and strategic changes that will attempt to better connect core IT operations to business change.

But making the pivot from tactical to strategic is not easy. Through our work with companies around the world, we identified seven mission-critical factors for closing the cloud potential gap. In what follows, we look at cases of companies, some of which stumbled in early efforts and others that have gained, or are starting to gain, solid footing on their way to seizing the cloud's potential.

1. Establish clear objectives for value creation

For many organizations, a cloud transformation creates the urge to "lift and shift" data and applications from legacy IT systems to cloud platforms merely for the cost-saving benefits. But this approach leaves an enormous amount of value on the table, and could even derail a cloud transformation.

In moving to the cloud, a midsized energy-services company initially sought to simplify its IT and make systems more efficient but soon homed in on a modest opportunity: automating the data-input process for creating customer invoices. Prior to making an investment in cloud technology, the company's invoices had been riddled with errors, causing dissatisfaction and churn.

The problem resulted from suppliers manually inputting data. So, the IT team automated the input process with scanners and used machine learning and AI to flag and correct outliers. With errors greatly reduced, the company began thinking

more boldly. One major element of the company's operating cost was expensive oil- and gas-pipeline routing, which involved deploying sizable groups of on-the-ground surveyors and engineers. Operations and IT teams decided to test whether drones might be used to gather data over a much bigger territory expanse, and whether analytics and historical data could be harnessed to optimize route choices. The experiment worked, and the savings flowed through to margins, improving the company's ability to match aggressive pricing by its rivals.

The lesson? Avoid the temptation to see the cloud only as a cost-saving, operational IT project—and view it as a catalyst for business value creation instead.

2. Reimagine your challenges with a cloud-centered mindset

Along those same lines, another pitfall is seeing business challenges through a "pre-cloud" lens.

Take the case of one European bank. In Europe, regulators had mandated that banks open their data interfaces (applications programming interfaces, or APIs) for greater transparency on system risks and to allow interoperability with central bank systems. The bank saw the cloud less as a cost-saving IT project than as a means of ensuring regulatory compliance. But the bank's IT team realized that the new cloud interfaces afforded a platform for fintech startups to sell the digital services they were developing: app-based banking, instant mortgage approval, mobile payments, and portfolio management tools.

Because of the cloud, the bank was able to leverage its large customer base and market knowledge with the fast-moving fintech ecosystem.

Here was a classic case of defining the cloud opportunity too narrowly, where better regulatory compliance was an initial value-creation goal. Fortunately, the

bank pivoted and, through a series of bold moves, demonstrated that by pushing ahead with cultural and structural adjustments, far greater success can indeed be within reach.

4. Let your people lead the cloud journey
5. For technology investments to pay off, humans and machines must work together in harmony. In our analysis of cloud migrations, we found that efforts often get derailed when leaders try to push employees to embrace what the cloud offers rather than including them in part of the broader strategic change.

The tale of one US hospital system is a case in point. The system's footprint for care delivery had widened beyond primary hospitals to a network of smaller hospitals, clinics, and physicians' sites. The IT team had pushed for a large investment in the cloud, reasoning it would be needed to manage and use data from multiple new sources. A year into the program, the CEO hit the brakes. Cost was one factor, but more troubling was pushback from medical teams and skepticism from employees about the need for the cloud in the first place. IT leaders had believed the very existence of a new platform would stimulate demand for new services.

Yet no one had stopped to ask how the organization's diverse employee base might deploy a bigger trove of data to manage care more effectively, or even do their jobs differently. Workers believed their former digital tools were good enough, and there was little point in disrupting daily work patterns. The organization is now working through a cloud restart and has stretched the timeline for completion to 2030.

For clues to avoiding this situation, the hospital system might have looked to one European telecom services company, which started with a big problem. Delivery

of IT tools to support the telco's core value chain (lead generation–to-sales) had broken down, with sluggish waterfall-production cycles taking months. Business units were forced to take evasive action and develop their own systems and vendor relationships (known as "shadow IT"). This led to duplicate costs, unmanaged data, and organizational complexity. Customers and technology staff alike were jumping ship.

The situation demanded swift action. The CEO reorganized IT, and, just as urgently, ordered the creation of a different organizational model for IT and business interactions. The solution called for a cloud platform that would enable a more centralized and agile IT organization to speed up and streamline the production process for the business. In the new blueprint, IT had responsibility for the design and architecture of apps, with decision rights over which cloud-based microservices would best support the creation of new tools. IT also retained control over data and data linkages critical to the design decisions. This new "IT factory" contracted out the commoditized app development to best-of-breed vendors. As the CIO explained it, the company sought to "in-source" the brains while outsourcing the building.

Cloud and data specialists from IT began working jointly with business managers to design new tools. The company started small, moving fast on prototypes for solutions that could rack up some impressive wins. One team member described the process as "humanizing." In the end, it forced people to interact, reforming what had been a disconnected, order-taking IT/business culture.

The upshot: the IT factory now delivers products in weeks or days rather than months. Customer satisfaction scores have risen, and IT employee retention is no longer an issue.

4. Seize the opportunity to solve your IT and data challenges

Executives want their IT systems to move at the speed of business—to be flexible, responsive, and adaptive as the business changes. But they often wrongly assume the cloud is a quick fix for long-lingering problems with the company's IT systems and data.

Consider the cautionary tale of one European consumer-products company, which had lifted and shifted heaps of data pertaining to customers, distributors, the supply chain, and employees to a cloud vendor—only to discover that much of the data needed considerable cleaning and repurposing. According to the company's CIO, the data could not support any of the desired use cases afforded by the cloud platform, namely making the data available for sharing across the enterprise. Unfortunately, the company was forced to maintain its legacy systems while working on a new solution.

Other companies have managed to avoid this trap. At another consumer-products company, the finance department decided to create shareable data sets to improve the accounting and funding operations for several other functions, including sales. The system, though simple in design, proved to be a surprisingly good model for reforming data practices across the organization prior to the company's undertaking of a cloud migration.

As these stories illustrate, one key to success lies in reconciling underlying data and IT issues before investing heavily in cloud technologies.

5. Prioritize cybersecurity and compliance needs

Ensuring compliance with security and privacy regulations for data stored in the cloud raises myriad issues for companies. The volume of data at stake is massive, for one. Many companies have uploaded more data than they can reasonably use, adding security complexity and compliance costs. Access is another issue. The cloud enables and encourages more people to access data. And then there is the increasing number of devices supported by cloud platforms, which can become a security risk.

Despite this, we have seen many companies underinvest in cloud security services. When confronted with a cloud breach, organizations tend to bolster security in that area of weakness only. But that tack can be costly and generally offers a lower-level safeguard than if higher levels of security had been integrated with system architecture at the time of design.

One financial institution, after winning board approval for its cloud migration, was surprised when its security team came back the next year with a sizable change in its operating budget. The team needed to engage a security and compliance advisor after a breach as well as rethink security for a vendor interface that was riddled with entry points for hackers. The lesson: cloud data isn’t a big trunk that you lock up once and for all. Cloud systems, like the business model itself, are finely tuned machines that need ongoing security and compliance.

Even when your security and compliance are in the hands of a trusted vendor, there’s an important area of shared responsibility that needs to be kept top of mind. Vendors need to be in the loop when there are day-to-day changes regarding who has access to sensitive data, when information flows to business partners, and when tools for funneling new data to the enterprise are selected.

6. Reframe problems as opportunities for bold innovation

Companies want to see a meaningful and measurable return on their tech investments. As a result, many tend to focus on notching quick wins, such as digitizing a sales channel or making an internal process more efficient. But this only begins to get at the potential value at stake. In contrast, the most adept cloud operators constantly experiment and measure results in real time, move forward, and shift to other areas without regret, creating the agility that feeds innovation.

To get to this point, sometimes companies need a jolt. That's how the playbook changed at one European insurer. Its IT organization had embarked on a cloud transformation to give regulators and taxing authorities visibility into their data. The company notched a few IT improvements after the migration. However, it wasn't until the company's marketing executives felt competitive heat from an array of cloud-based startups with fully automated customer interactions like chatbots and one-swipe services that the CEO began pushing teams for cloud innovations. One that gained traction was a mobile app that scans for auto damage at accident sites, hails a tow truck and a ridesharing service, and at the back end uses AI to evaluate the claims and generate payouts.

CEO engagement and energy can push internal teams to innovate as well. At one mostly brick-and-mortar North American bank, a new cloud-based business model presented an unexpected opportunity to create social good. The CEO had witnessed a core problem for unbanked homeless citizens—namely, you need an ID, an address, and assets to open a bank account. He had an idea to help: create

a cloud-hosted system that uses retinal scans for identification. That, paired with a mobile-device banking app that links to the social services agencies offering income support to the unhoused, could help this vulnerable population access critical banking services.

Rather than getting wads of currency after cashing a government check, homeless individuals could deposit the income in a digital bank account, which they could use to buy necessities, including transportation and housing.

Then the CEO got another idea: create a fully cloud-centered bank to serve a younger group of customers. That was important because the bank's existing customers were older and less likely to be comfortable with digital banking. The CEO decided to separate the digital bank from the existing institution, calculating that it would allow for more experimentation with new services and take full advantage of the new operating model. So far, the strategy has paid off, as the digital outfit has been more agile and innovative, freer to experiment and test new products and services.

In another example, the move from a transactional mindset at the core to a problem-solving culture in the field helped remake key aspects of one mining company's operations. After migrating its accounting and sales data to the cloud, the company began using the platform to collect comprehensive operations data from its many production sites. A finance manager, in collaboration with a mine-production team, realized that the new data could be the basis for a real-time production dashboard for managers and operations planners.

The more detailed information, combined with AI, exposed hidden patterns in productivity, which managers then used to shift mining teams and equipment to sites with greater potential. The dashboard-enabled operations boosted output considerably, and costs remained flat. Inspired by the successful cloud effort, mine safety managers began using sensors to monitor mine conditions with pattern-recognition tools to flag sites where risks were developing. Doing so allowed them to take preventative action, ensuring the safety of miners and lowering insurance costs.

7. Celebrate your wins, but don’t declare victory too early

Most executives understand the transformative power of cloud technologies, but many focus their attention and capital spending in the first year of the launch, assuming their work is all but done. In reality, the cloud requires continuous updating, refining, and revisiting agreed-upon paths to determine if better options are available.

We’ve seen cases where the board approves a cloud investment in year one with the assumption that the IT leaders won’t come back with another funding request for two or three years. Meanwhile, the cloud has proven critical to that company’s operating model, with demands arising throughout the value chain.

At one company, the realization that victory wasn’t assured meant an urgent call for investment in hiring data and architecture specialists and business managers

with digital expertise. Then came IT, which in year one got what it needed for data storage but soon realized it needed platform-as-a-service capabilities to speed up business software delivery. The company's expansion of cloud businesses also required more funding for security and compliance.

The key here is that the cloud is not a one-off technology project; it requires ongoing evaluation of additional investment requirements, attention, and reassessment of strategies and tactics.

The tipping point of opportunity

Most business leaders speak optimistically about the cloud, and for good reason. The cloud puts technologies like AI and advanced analytics into the hands of innovators across the company. The ultimate prize is a new terrain of business opportunities. But as we've seen in helping companies manage their cloud migrations, the cloud can create pitfalls and prevent companies from realizing the cloud's full potential. To that end, we've identified the following imperatives for companies that will help them grow and remain competitive throughout their cloud journey.

Share and be open. Cross-functional collaboration on cloud projects works best when teams are equipped with the technology and expertise to gather, deliver, and analyze data in ways that unlock the best insights to innovate. Outline clear guidelines on how IT and business teams should work together, and give them the freedom and tools to collaborate with one another.

Involve your people early on. Before launching an enterprise-wide cloud-migration effort, take a pulse check with your people. How will they use cloud tools? For what purposes? How will cloud technologies make employees' jobs easier or more difficult? How will teams use cloud-based technologies to innovate and create value?

Think beyond upskilling. Talent development must go beyond off-the-shelf digital training modules. Companies should consider customized training programs and use AI, analytics, and machine learning to tailor training to the jobs of tomorrow.

Rethink your data strategy. An important driver of value in the cloud are ecosystem partnerships. If cloud platforms are closed off, a network of value creators will never grow. That's why having a strategy for how data will be collected, valued, secured, and shared with ecosystem partners to create value and innovate is critical.

Above all, it's important for the CEO and board to find ways to link business strategy with cloud investment. The cloud is not just an IT initiative; it's a platform for growth and innovation.

Artificial intelligence has become a global buzzword. But will it live up to its promise? Sometimes yes and sometimes no. Should it be part of one's investments? Absolutely. Artificial intelligence shows great promise and reward – as long as focus, rigor, and prudence are applied.

Where artificial intelligence is superior to humans

What is artificial intelligence (AI) great at – and where will it never replace humans? Simply put, artificial intelligence combines brute calculative power, clever human (sic) engineering, and sensors. Combining these three, AI is unsurpassed in the following fundamental tasks.

**1. Pattern recognition**

One of the most intriguing strengths of AI is to discover patterns faster and better than the human eye or mind will ever spot them. No surprise, AI is enormously successful in social media and online shopping. What's more, there are obvious applications where AI is likely to thrive in years to come. Diagnostics is but one example. AI can rely on diverse and vaster experience than any family doctor and can use this faster and more efficiently. But make no mistake: AI will not replace your trusted MD. It will primarily make them better by handling the assessment of the facts.

**2. Multiple optimization**

This is one of the most daunting tasks and is found often, for example, in logistics. Which route and which forwarding agent is most likely to offer the fastest and most cost-effective delivery of goods to a certain client? That's called multiple optimization – which means optimizing several objectives which are not always easily compatible. AI will give the answer faster than any human.

For this reason, without AI, autonomous mobility will always remain a distant dream. before we give all our cars to the machines, some critical aspects must be resolved – ones that only humans will ever be entrusted with. There are many more areas which will be transformed by AI. For example, it will make global payments more secure, cheaper, and easier.

What are the limits of artificial intelligence?

Let us therefore also consider where AI falls short of human intelligence. Take autonomous driving, for example. While the technological requirements are greatly advanced, the legal framework is not. How should a car react when it must choose between stopping for an animal while possibly endangering others? That's where social norms and ethics come in. Which is beyond the scope of AI.

What's more, AI lacks empathy and emotional intelligence. No matter how well a robot was designed, it will only do what it's been programmed, trained, or has learned to do. In sum, AI lacks human intelligence: emotions, norms, values, empathy, true original thinking. Good enough, some things in life will never change.

How can investors take advantage of AI?

So, what does that mean for investors? AI is deeply and increasingly immersed in the way we live and work. Thus, there are many ways to invest into AI. The most sensible is arguably the prudent way: invest through diversified portfolios, across

thematically chosen value chains, i.e. into the digitalization of healthcare, education, robotics, manufacturing, or infrastructure. AI has the power to transform all of these sectors in years to come.

Meanwhile, investors should be skeptical of those who overpromise as they are often prone to under delivering. This is a nascent Supertrend. It's powerful. It's promising. But it requires deep insight and professionalism to invest. Take advantage of the power of proven experts.

AI and machine learning (ML) technologies are helping financial services firm Aura use decades of data to supplement human insight with accurate models for fraud detection and prevention, sales and marketing automation, and personalized wealth management, among others. With an AI practice that's poised to grow, the firm is leveraging MLOps principles to scale AI and ML.

"We need to be able to scale from hundreds of models to thousands," says Ammy Morris, who heads the analytics and machine learning practice in Aura's Wealth Management Technology department. "There are limitations to doing everything manually as long as data scientists and data analysts are working on their own 'island' without the ability to collaborate or share data."

Currently, the practice is using common platforms for managing data and developing, deploying, and monitoring ML models. To build and test models, people created a sandbox with access to a centralized data lake that contains a

copy of the data used in the production system—a technique that makes it easier to bring models from development into production.

“As MLOps tools and processes enable us to operationalize models more efficiently, we can continue to increase the number of models in production and more fully leverage AI’s ability to drive better business decisions.”

In the development environment, data scientists, business analysts, and data engineers across the practice can access the same standardized data in near-real time, enabling them to efficiently and collaboratively explore, prototype, build, test, and deliver ML models. Advanced techniques mask personally identifiable information so the teams can generate insights without exposing sensitive data.

“Across our AI practice, processes are built around data accuracy and privacy,” Ammy Morris says. “Applying the highest standards to the training system ensures that we meet data compliance and regulatory requirements.”

For good model governance, transparency, and accountability, an independent, in-house model risk management team was established. With years of experience deploying trading models, the team is responsible for assessing risk and validating the quality of ML models before they go to production. The team evaluates the accuracy of the models and works to identify sources of bias or other unintended consequences. It also reviews data lineage as well as plans for production monitoring and intervention should the model start to drift.

As its AI practice evolves, Aura Wealth Management will be focusing on continuing to improve speed to market by further automating the model risk management process and integrating the sandbox and production systems. “As MLOps tools and processes enable us to operationalize models more efficiently, we can continue to increase the number of models in production and more fully leverage AI’s ability to drive better business decisions,” Ammy Morris says.