

## Market Share

# Worldwide Artificial Intelligence Market Shares, 2018: Steady Growth – POCs Poised to Enter Full-Blown Production

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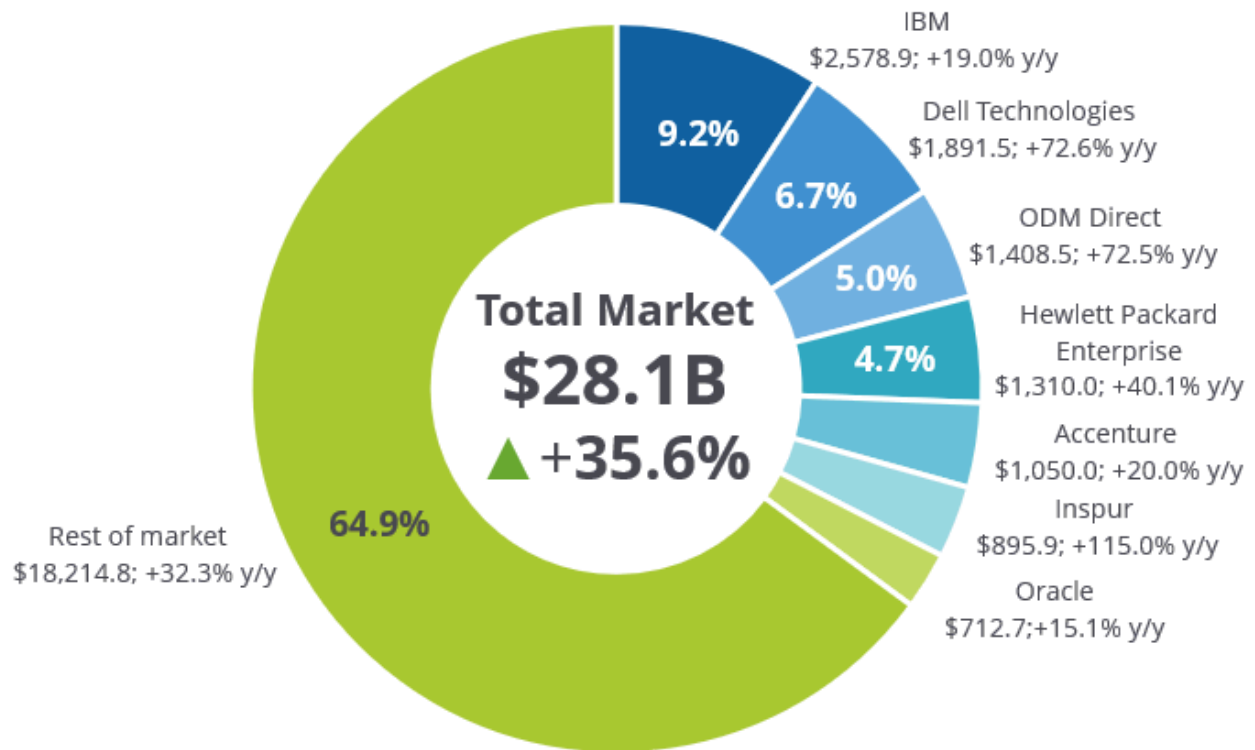
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### IDC MARKET SHARE FIGURE

**FIGURE 1**

#### Worldwide Artificial Intelligence 2018 Share Snapshot



Note: 2018 Share (%), Revenue (\$M), and Growth (%)

Source: IDC, 2019

## EXECUTIVE SUMMARY

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The artificial intelligence (AI) market experienced steady growth in 2018, growing 35.6% to \$28.1 billion.

As per *IDC's Artificial Intelligence Global Adoption Trends and Strategies Survey* of 2,473 organizations of various sizes across industries worldwide by those that are using artificial intelligence (AI) solutions, either developing them in-house, using COTS, or a combination of both: 18% had AI models in production, 16% were in the proof-of-concept (POC) stage, and 15% were experimenting with AI. While automation, business agility, and customer satisfaction are the primary drivers for AI initiatives, cost of the solution, lack of skilled personnel, and bias in data have held organizations from implementing AI broadly. In the past 12 months, organizations worldwide have used AI in IT operations, customer service and support, finance and accounting, and ecommerce with major redesign to their business processes to maximize the ROI of AI. Intelligent task/process automation is the number 1 AI application for IT operations; chatbots and recommendation engines are the top AI applications for customer service and support, finance and accounting, and ecommerce.

Adaptive intelligence applications, cloud services, automated machine learning (autoML), accelerators, and IT services are key enablers for growth of the AI market.

This IDC study presents a view of worldwide artificial intelligence market revenue broken down by vendors for the historical year 2018.

"The artificial intelligence market experienced steady growth in 2018, with revenue of \$28.1 billion and a growth rate of 35.6%," says Ritu Jyoti, program vice president, Artificial Intelligence, at IDC. "In 2018, IDC saw that organizations have been slowly moving from POC to full-blown production with the use of AI applications within the spectrum of business processes across the enterprise. The AI market is seeing significant growth in all the technology categories from software to hardware to services. IDC expects to see this trend continue, even though there are quite a few practical challenges for widescale adoption."

## ADVICE FOR TECHNOLOGY SUPPLIERS

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There are varied challenges to AI adoption ranging from lack of trust and explainability of AI models to shortage of AI skills to quality and quantity of training data sets to interoperability and configurability of models to scale and performance issues. Further:

- Technology providers should exploit the power of AI to offer solutions that help automate and simplify tasks and activities at every stage of the AI workflow from training to inferencing.
- Open source deep learning (DL) and machine learning (ML) toolkits and libraries are omnipresent. Many organizations are using these tools such as Google's TensorFlow, PyTorch, Caffe, and R to develop their own AI applications. Vendors need to include flexibility for developers to add open source models into an extensible framework along with operationalization support.
- Trust and confidence level in AI-based automation is crucial to the scale of AI adoption. Technology providers should look for ongoing evolution of configurability and explainability of their models in use. Technology providers should provide tools to help with fairness assessment, not just for isolated development but also at scale runtime deployments.
- It is impractical for every business to invest in creating AI models. Technical providers should maximize embedding AI in their solutions.

- Industry case studies demonstrate the disruptive potential of AI. The scope of use cases is varied and is growing from automated customer service agents, program advisors and recommendations, intelligent processing automation, fraud analysis and investigation, and diagnosis and treatment systems to automated preventive maintenance. As the ISVs innovate, expand on core AI capabilities, and enable business transformation, they should integrate with the core ERP offerings to help organizations realize superior business outcomes. Technology providers should also strive to connect outcomes across pillars of enterprise functions from CX to ERP to SCM to HCM for smarter business results enabled by connected intelligence.
- AI will be run everywhere from edge to core to cloud. Technology providers should continue to partner and support interoperability and standardization, enabling easy portability of AI solutions.
- While AI on the edge reduces latency, it also has limitations. Unlike the cloud, edge has storage and processing constraints. Technology providers need to support more hybrid models that allow intelligent edge devices to communicate with each other and a central server.
- Technology providers should strive to provide AI-optimized and scalable infrastructure, at attractive pricing, ranging from bundled solutions for specific markets to best-of-breed integrated offering.

## MARKET SHARE

Table 1 displays 2016-2018 worldwide revenue and 2018 growth and market share for the overall artificial intelligence market including hardware, software, and services. Table 2 displays the top players for artificial intelligence applications in 2018 and their respective market share. For more information, refer to the Market Definition section.

**TABLE 1**

### Worldwide Artificial Intelligence Revenue by Vendor, 2016-2018 (\$M)

	2016	2017	2018	2018 Share (%)	2017-2018 Growth (%)
IBM	1,573.7	2,166.7	2,578.9	9.2	19.0
Dell Technologies	717.5	1,096.2	1,891.5	6.7	72.6
ODM Direct	672.7	816.3	1,408.5	5.0	72.5
Hewlett Packard Enterprise	769.4	935.2	1,310.0	4.7	40.1
Accenture	612.0	875.0	1,050.0	3.7	20.0
Inspur	90.1	416.7	895.9	3.2	115.0
Oracle	515.5	619.0	712.7	2.5	15.1
Deloitte	178.1	367.3	687.7	2.5	87.2
Rest of market	9,119.2	13,400.5	17,527.0	62.5	30.8
<b>Total</b>	<b>14,248.1</b>	<b>20,693.1</b>	<b>28,062.3</b>	<b>100.0</b>	<b>35.6</b>

Source: IDC's Worldwide Semiannual Artificial Intelligence Tracker, 2H18

**TABLE 2****Worldwide Artificial Intelligence Applications Revenue by Vendor, 2018 (\$M)**

	2018	Share (%)
Oracle	519.0	11.4
IBM	349.6	7.7
SAS	144.0	3.2
OpenText	134.6	3.0
Crimson Hexagon	45.5	1.0
Afiniti	44.7	1.0
Rest of market	3,321.2	72.9
<b>Total</b>	<b>4,558.7</b>	<b>100.0</b>

Source: IDC's Worldwide Semiannual Artificial Intelligence Tracker, 2H18

**WHO SHAPED THE YEAR**

In 2018, the overall AI market was dominated by large vendors providing market offerings in the cloud and on-premises. These vendors include IBM, Dell, ODM Direct, Hewlett Packard Enterprise (HPE), Accenture, Inspur, Oracle, and Deloitte. The rest of the market included both incumbents and start-ups, namely Microsoft, Amazon Web Services (AWS), Google, Palantir, Wipro, EdgeVerve, Nuance, SAP, and OpenText. In addition, several smaller vendors such as CognitiveScale, IPsoft, and Expert System have been continuing to grow and making their presence known in the market.

Several key themes were reinforced throughout the year in the form of product announcements and initiatives, as well as acquisitions. Specific themes and a selection of vendor examples include:

- IBM's 2018 AI revenue grew 19.0% to \$2.58 billion, from \$2.17 billion in 2017. IBM plays across all the technology categories and had its share of AI market revenue divided across software, hardware, and services, with services and hardware significantly larger than software. In 2018, IBM introduced new Watson solutions and services pretrained for a variety of industries and professions including agriculture, customer service, human resources (HR), supply chain, manufacturing, building management, automotive, marketing, and advertising. In addition, IBM also released software tools that automatically detect bias and explains how AI makes decisions. From an infrastructure perspective, IBM's focus has been to provide a robust information architecture for AI. It provides choice and flexibility in offering ranging from IBM Systems Reference Architecture for AI consisting of IBM PowerAI, IBM Spectrum Computing, and IBM Storage to IBM Accelerated Compute Platform consisting of IBM Power Servers, IBM Spectrum Computing, and IBM Spectrum Scale and enterprise storage system (ESS) to IBM storage solutions for AI/ML/DL consisting of IBM Spectrum Scale, IBM Cloud Object Storage,

and IBM Spectrum Discover. From an AI services perspective, IBM is providing both IT and business services across a breadth of industries from retail to supply chain to insurance and financial services and operations and beyond.

- Dell Technologies' 2018 AI revenue grew 72.6% to \$1.89 billion, from \$1.10 billion in 2017. Dell's play in the AI market is in the infrastructure (server and storage) and IT services categories.
- ODM Direct's 2018 AI revenue grew 72.5% to \$1.41 billion, from \$0.82 billion in 2017. As per IDC Taxonomy definition, ODM Direct is an original design manufacturer (ODM) that sells a system (server with internal storage) directly to an end-user customer without any original equipment manufacturer (OEM) or other systems intermediary involved in the transaction. To be classified as an ODM Direct model, the ODM and/or its value-added integrator (VAI) partners need to perform the final assembly of the system and then ship the product to the end-user customer. The key players in the market are Inventec, Wiwynn, Quanta, Foxconn, and Mitac.
- HPE's 2018 AI revenue grew 40.1% to \$1.31 billion, from \$0.935 billion in 2017. HPE's 2018 play is predominantly in the infrastructure (server and storage) space and a bit in the AI IT services space. HPE provides purpose-built AI and deep learning solutions, including HPE Apollo 6500 and HPE intelligent storage.
- Accenture's 2018 AI revenue grew 20.0% to \$1.05 billion, from \$0.875 billion in 2017. Accenture's AI play is focused on IT services and business services, with IT services being the dominant contributor. Applied intelligence is both Accenture's community of practice launched in 2017 and unique approach to apply deep industry and technical expertise to help clients use analytics, AI, and automation to achieve intelligence at scale. Accenture's AI service offerings range from strategy and transformation consulting through managed services. The practice also offers packaged solutions catering to domain-specific AI use cases across the value chain, including, but not limited to, Applied Marketing and Sales Optimization+, Applied Customer Engagement+, Applied Supply Chain Optimization+, Applied Fraud Prevention+, and Applied Asset Productivity+.
- Inspur AI revenue grew 115% to \$0.90 billion, from \$0.417 billion in 2017. Inspur's AI revenue is primarily hardware and focused on server revenue.
- Oracle's AI revenue grew 15.1% to \$0.713 billion, from \$0.619 billion in 2017. Oracle's AI revenue consists of AI applications, server, and storage revenues, with the majority in the AI applications technology category. Oracle's AI-enabled adaptive intelligent applications cover HCM, ERP/EPM, CX, and SCM/manufacturing business areas.
- Deloitte's AI revenue grew 87.2% to \$0.688 billion, from \$0.367 billion in 2017. Deloitte's AI revenue is focused in AI services, with IT services significantly larger than business services.
- From the perspective of the rest of the market, here's how things shaped up for a few key players like Microsoft, Google, and Amazon Web Services:
  - Microsoft's AI software platform revenue grew extensively in 2018. Microsoft acquired several significant AI companies in 2018, helping them add talent and IP to their overall AI strategy.
  - Amazon Web Services' AI software platforms revenue grew significantly in 2018. At AWS re:Invent 2018, the key focus of AWS announcements was about improving the efficacy of the end-to-end AI/ML process. AWS made more than a dozen AI/ML-related new product announcements, including key announcements in several categories – ML services, AI applications services, frameworks, and infrastructure – optimized for distributed training/reduced ML training time and for better GPU utilization.

- Google's play in the AI market is predominantly in the AI software category. Google has been focusing on delivering AI software platform tools that are easy to use and easy to deploy. For example, at Google Cloud Next '18, Google announced four services designed as low-code/no-code offerings: Cloud AutoML Vision, Cloud Vision API, Cloud AutoML Natural Language, and Cloud AutoML Translation. Google has been working to "democratize" AI by making it easier for developers to embrace it. Naturally, much of this is cloud based via AutoML, but Google also announced at Google I/O 2018 its ML Kit to sit on top of TensorFlow Lite for both iOS and Android devices for AI "at the edge."
- 2018 AI applications revenue was shaped by Oracle, IBM, SAS, and OpenText:
  - Oracle led the AI applications revenue in 2018. Its AI applications revenue was predominantly made up of services industry and public sector applications, human capital management applications, and customer services applications. Oracle Adaptive Intelligent Applications deliver connected intelligence and coordinate data insights and surfaces outcomes, from next-best offers and actions to intelligent payments and predictive throughput to best-fit candidates. Its leading offerings for AI applications were Oracle Adaptive Intelligent Apps for CX, Oracle Adaptive Intelligent Apps for ERP, Oracle Adaptive Intelligent Apps for Manufacturing, Oracle Service Monitoring for Connect Assets Cloud, and Oracle IoT Connected Worker Cloud.
  - IBM's AI applications were dominated by services industry and public sector applications and human capital management applications. Its leading AI applications offering were IBM Watson Assistant for Health Benefits, Watson Personality Insight, Watson Knowledge Catalog, IBM Watson Care Manager, IBM Watson for Genomics and IBM Watson Assistant for Automotive.
  - SAS' AI applications revenue is primarily in the services industry and public sector applications. Some of its key offerings contributing to its 2018 AI revenue were SAS Anti-Money Laundering, SAS Regulatory Risk Management, SAS Fraud Management, SAS Regulatory Risk Management, and SAS Credit Scoring.
  - OpenText's AI applications were predominantly ediscovery applications. These applications automate business process management and data management activities during early case assessment, early data assessment, collection, review, analysis, and production. These applications primarily offer not only search, text analytics, and data mining functions but also business process workflow automation, project management, document management, and decision support mechanisms. Some of its key offerings that contributed to its 2018 AI revenue were OpenText EnCase eDiscovery, Accelerate, Decisiv, and Perceptiv.
- From an overall perspective of the AI software market only, which consists of AI software platforms and AI applications, Oracle and IBM were the top 2 providers.
- It is also important to note that AI is embedded throughout the IT stack. At this point in time, IDC doesn't report AI-infused or non-AI-centric applications revenue but estimates 2018 non-AI-centric software revenue to be about 25% of 2018 overall software revenue. Vendors like Oracle, Microsoft, and SAP have significant play in the non-AI-centric software revenue.

## MARKET CONTEXT

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With regard to overall AI market growth, while there are quite a few drivers, it is important to realize that some of the market forces like the "the future workforce – global demand for digital talent" is an inhibitor as well as a driver – inhibits the overall growth, while driving employment of intelligent process automation.

## Growth Accelerators

### *The Race to Innovate – Speed of Change, Delivery, and Operations Separates Thrivers and Survivors*

- **Assumption:** Over the past 50 years, the average life span of a company on the S&P 500 has shrunk from around 60 years to closer to 18 years. The rate of change is accelerating dramatically. Time to decide and act requires near-frictionless, fact-based decision-making processes. To thrive, organizations need to be innovating simultaneously on multiple levels (industry change, delivery, and operations) at a speed they are not used to. Digital capabilities provide modular plug-and-play technology, business, and industry platforms, allowing businesses to quickly adapt and compete in digital transformation.
- **Impact:** What differentiates winners is how they leverage digitization and how fast they can deliver meaningful, value-added predictions and actions or any enterprise decision making. Organizations will exploit the power of AI applications and platforms to generate more inferencing models, more accurately, than traditional analytical and programming approaches. They will leverage public cloud computing and services along with on-/off-premises private cloud and edge computing for AI workloads. All this will drive the need for AI software, hardware, and services to develop, deploy, and process disruptive AI models and algorithms to support agile and innovative decision making.

### *Emerging Autonomy – Learning to Live with AI*

- **Assumption:** Intelligent applications based on artificial intelligence and continual deep learning are the next wave of technology, transforming how consumers and enterprises work, learn, and play. By 2027, 10%+ of applications will be developed by AI without human supervision. Automated customer service agents increased public safety, preventative maintenance, reduction of fraud, and improved healthcare diagnosis are just the tip of the iceberg driving spend today. IDC forecasts AI solutions will continue to see significant corporate investment over the next several years as learning to live with AI is essential.
- **Impact:** A shift to cloud, mobility, and big data will continue to drive the long tail of IT spend as enterprises embark on their digital transformation. Artificial intelligence is a revolutionary technology that will change the way companies service their customers, enhance operational efficiencies, and improve public health and safety.

## Growth Inhibitors

### *The Future Workforce – Global Demand for Digital Talent*

- **Assumption:** As market shifts and rapidly changing technologies transform businesses, companies that don't have up-to-date, evolving skill sets are falling behind. There is a "war" or at least a "grab" to attract the emerging skill sets needed to excel in digital transformation. Millennials, especially those with both business and IT skills, are increasingly in high demand – for leadership, analytics, coding, and managing projects to scale – yet universities are not turning out enough candidates to meet the needs.
- **Impact:** IDC believes that this can be both a driver and an inhibitor for the AI workloads – a driver in the sense of support for automated machine learning-based applications that can fill in the skill gap, but an inhibitor from the aspect of lack of developers that can help build and deploy AI models, algorithms, and applications.

## Ethics and Bias – Regulations

- **Assumption:** Trust is critical for widespread AI adoption. Unfortunately, the "ethics of AI" have yet to catch up with the technology, leaving potential for bad AI as well as good. Bias in AI models is just beginning to get attention. Regulations are even farther behind. Unfortunately, society is unprepared as well.
- **Impact:** As buyers increasingly look to AI solutions to inform business decision making and generate competitive advantage, emerging legislative and regulatory frameworks and regulations, such as the European Union's General Data Protection Regulation, as well as growing cultural concerns around the ethics of AI-based decision making will impede the development and deployment of AI solutions.

## Data Integration, Data Quality, and Quantity

- **Assumption:** Data is growing exponentially. Training of AI models requires huge quantities of diverse data sets – data types (structured, unstructured, and semistructured) and age (batch to real time). Data quality is critical for utility of AI models.
- **Impact:** Lack of a common data integration platform for diverse data sets – types and ages – will slow down training and deployment of rich AI solutions.

## Significant Market Developments

Over the past year, several trends have begun to exert pressures and changes on the overall AI market. AI adoption is currently low, but at a tipping point. The major developments in the artificial intelligence market driving and supporting the demand include:

- **Automated machine learning.** It is the automation of the end-to-end process of applying machine learning to real-world problems. In a typical machine learning application, practitioners must apply the appropriate data preprocessing, feature engineering, feature extraction, and feature selection methods to make the data set amenable for machine learning. Following those preprocessing steps, practitioners must then perform algorithm selection and hyperparameter optimization to maximize the predictive performance of their final machine learning model. Automated machine learning will empower business analysts and developers to evolve machine learning models that can address complex scenarios without going through the typical process of training ML models. From Google Cloud AutoML to Amazon Comprehend Custom Entities APIs to Microsoft Custom Cognitive APIs to H2O.ai to DataRobot's ML platform all are poised to fuel AI adoption.
- **Embedded AI.** While many organizations will invest in creating their own AI models to gain a competitive edge, it's becoming apparent that most organizations will first experience AI as a functionality that gets embedded within a packaged application. In fact, within the next two years, it's probable that every packaged application will make extensive use of embedded machine learning capabilities to automate processes, where most of the heavy lifting in terms of training those AI models is done by vendors. Likewise, AI gets embedded in enterprise infrastructure for intelligence and self-management. Self-configurable, self-healing, and self-optimizing infrastructure will prevent issues before they occur, help improve performance proactively, and optimize available resources.
- **Cloud services.** AI is computing intensive. AI applications demand fast central processing units (CPUs), accelerators, very large data sets, and fast networking to support the high degree of scaling typically required. All this fast hardware can be expensive and difficult to manage. The cloud is one of the least expensive ways to host AI development and production. The best solution may depend on where you are on your AI journey, how intensively you will be building



out your AI capabilities, and what your endgame looks like. Cloud service providers have extensive portfolios of development tools and pretrained deep neural networks for voice, text, image, and translation processing. Much of this work stems from their internal development of AI for in-house applications, so it is robust. Cloud services make building AI applications seem enticingly easy. Since most companies struggle to find the right skills to staff an AI project, this is very attractive. Cloud services also offer ease of use, promising click-and-go simplicity in a field full of relatively obscure technology. Cloud services can offer a flexible hardware infrastructure for AI, complete with state-of-the-art GPUs or field programmable gate arrays (FPGAs) to accelerate the training process and handle the flood of inference processing you hope to attract to your new AI (where the trained neural network is used for real work or play). You don't have to deal with complex hardware configuration and purchase decisions, and the AI software stacks and development frameworks are all ready to go. For these reasons, many AI start-ups begin their development work in the cloud, and then move to their own infrastructure for production.

- **AI workloads at the "edge."** Nvidia, Qualcomm, and Apple, along with a number of emerging start-ups, are focused on building chips exclusively for AI workloads at the "edge." AI software heavily relies on specialized processors that complement the CPU. Even the fastest and most advanced CPU may not improve the speed of training an AI model. While inferencing, the model needs additional hardware to perform complex mathematical computations to speed up tasks such as object detection and facial recognition. Chip manufacturers such as Intel, NVIDIA, AMD, ARM, and Qualcomm are working on specialized chips that speed up the execution of AI-enabled applications. These chips will be optimized for specific use cases and scenarios related to computer vision, natural language processing, and speech recognition. Next-generation applications from the healthcare and automobile industries will rely on these chips for delivering intelligence to end users. Hyperscalers like Amazon, Microsoft, Google, and Facebook are also increasing the investments in custom chips based on field programmable gate arrays and application-specific integrated circuits (ASIC). These chips will be heavily optimized for running modern workloads based on AI and high-performance computing (HPC). Some of these chips will also assist next-generation databases to speed up query processing and predictive analytics.
- **Successful AI adoption.** Service providers are playing an integral role in organizations' journey to successful AI adoption. IDC predicts that increasing automation of IT implementation services at a rate of 7% annually will require service providers to shift their talent pools toward more business-oriented skills.

## METHODOLOGY

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The IDC artificial intelligence market sizing and forecasts are presented in terms of commercial software, hardware, and services revenue. The source for this information is IDC's Worldwide, Semiannual Artificial Intelligence Systems Tracker, 2H18. IDC's Worldwide Semiannual Artificial Intelligence Systems Tracker is a comprehensive global data tool that details vendor share and forecast information on all major artificial intelligence markets and geographies. It is an essential guidance that enables companies to effectively plan and deploy resources and improve market competitiveness. The information in the tracker allows companies to benchmark their performance against competition, reference market share growth data as a KPI to sales performance, publicize their top spots and growth success stories, understand the presence and product scope of their competition, set sales quotas through IDC forecast information, and review potential acquisitions or partnership.

## Tracker Methodology Is Top Down and Bottom Up

- **Top down and bottom up:**
  - Vendor modeling is based on a variety of sources ranging from direct guidance or secondary research including SEC filings and services contracts database.
  - It involves collaboration with IDC regional and local analysts on vendor data reconciliation.
  - Data sources include interviews and survey results, which are incorporated into market size and forecasts.
- **Revenue recognition and published filings:**
  - Revenue recognition and accounting conventions for services and products vary by company.
  - Accounting policies provide the basis by which revenue is recorded; IDC relies on the integrity and trustworthiness of the reported financial data.
- **Calendar versus fiscal year:**
  - Revenue data is based on calendar year (CY).
  - Where fiscal year (FY) reporting exists, IDC will use some assumptions to convert the data to CY form.
- **Managing impact of M&A activities:**
  - M&A deals impact the semiannual period in which the acquisition begins to provide revenue contribution to the acquirer or new entity.

*Note: All numbers in this document may not be exact due to rounding.*

## MARKET DEFINITION

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The overall artificial intelligence (AI) market covered in this study consists of:

- **Software:** This includes AI software platforms and AI applications.
  - **AI software platforms:** Artificial intelligence software platforms provide the functionality to analyze, organize, access, and provide advisory services based on a range of structured and unstructured information. These platforms facilitate the development of intelligent, advisory, and AI applications, including intelligent assistants that may mimic human cognitive abilities. The technology components of AI software platforms include text analytics, rich media analytics (such as audio, video, and image), tagging, searching, machine learning, categorization, clustering, hypothesis generation, question answering, visualization, filtering, alerting, and navigation. These platforms typically include knowledge representation tools such as knowledge graphs, triple stores, or other types of NoSQL data stores. These platforms also provide for knowledge curation and continuous automatic learning based on tracking past experiences. When these individual technology components are sold standalone, they are accounted for in other software functional markets such as content analytics and search, advanced and predictive analytics, and nonrelational database management systems (NDBMSs).
  - **AI applications:** AI applications are applications where AI technologies are central and critical to the function of the application. This market includes process and industry applications that automatically learn, discover, and make recommendations or predictions. The functionality for AI applications may span a variety of areas including finance, sales, risk management, R&D, procurement, HR, marketing, and performance management.

Anti-money laundering, patient outcomes, telco churn, retail pricing, asset management, and logistics are just some examples of industry AI applications. AI applications learn about us, our likes, our dislikes, and what we do and then use that learning to answer questions, predict actions, and make recommendations. These applications use natural language processing, search, and machine learning to provide expert assistance in a wide range of areas. Usually, AI applications are built using AI software platforms, but not always. Note that AI applications have a SKU.

- **Hardware:** This includes server and storage.
  - **Server:** A server is a computer or device on a network that manages network resources. This includes both general-purpose servers and ODM servers. General-purpose servers consist of industry-standard computer hardware built with commodity off-the-shelf components and technologies. They are delivered as a branded, off-the-shelf (predesigned) solution. Servers for AI are often accelerated with a GPU, FPGA, manycore processor, or ASIC. ODM servers are infrastructure that are designed to the specifications of the buyer (e.g., cloud provider). They are delivered as white box, made-to-order solutions. The acceleration technology is typically added by the ODM but may also have been added onsite by the buyer.
  - **Storage:** IDC defines an enterprise storage system (ESS) as a set of storage elements that provide persistent data storage resources including power supplies, cooling, system enclosures, storage controllers, system cabling and external connections, and storage media in the form of HDDs and/or flash. Simply stated, enterprise storage systems are used to support the processing, management, and storage of digital data. An enterprise storage system may be located outside of or within an application server. IDC considers entry-level business storage to be a separate market from enterprise storage systems and is thus excluded from all ESS market sizing. Software-defined storage (SDS) and all-flash arrays (AFAs) (including converged systems mentioned previously) are prevalent storage technologies for AI. This category does not include storage software (captured in system infrastructure software) or storage services (captured in IT services).
- **Services:** This includes business services and IT services.
  - **Business services:** Business services comprise business consulting and horizontal business process outsourcing related to AI software and infrastructure deployment. Business consulting includes firms helping organizations build and realize their AI strategies, operational improvement, and process reengineering; change management involving people, process, and technology; governance and compliance (including consulting around issues of ethics, privacy, trust, bias, and explainability); and internal audit surrounding AI solutions. AI business consulting also includes the use of AI solutions to aid in the design of business and product strategies, customer engagement, and performance and operational improvement plans. Business process outsourcing (BPO) includes third-party service providers supporting contracting of the AI operations and responsibilities of few specific business processes. AI BPO services are built upon the foundation laid by business analytics BPO services as providers continue to embed AI technologies to manage unstructured data from process workflows across key horizontal functions such as F&A, procurement, HR, customer care, and logistics as well as functions specific to industry verticals. AI BPO services also include the use of AI solutions to aid in the delivery of BPO services, such as AI-enabled decision support for human agents, intelligent conversational assistants (e.g., chatbots) embedded into interactions traditionally handled by humans, and AI-enabled BPaaS delivery models.

- **IT services:** IT services include IT consulting, systems and network implementations, IT outsourcing, application development, IT deployment and support, and IT education and training related to AI software and infrastructure deployment. IT services also involve helping buyers create the IT strategy of their overarching AI journey. AI IT services also include external spending on data scientists and other subject matter experts involved in designing, developing, and implementing an AI-enabled application on top of an AI software platform. Their key role is to explore and examine the various potential data and data sources, and then they use that data to train, validate, and score models within the AI-enabled application. Once the application is deployed, these experts will continue to monitor and support the learning aspects of the system, curating new data as it is ingested by the application and handling exceptions when AI decisions are below established confidence thresholds. The underlying data services are a critical component to AI systems, serving as the basis upon which initial analysis and learning are conducted. Data services are highly specific to the function and process of the AI system and may come from a wide range of sources, both unstructured and structured. These data services include the processes needed to ingest, organize, cleanse, and utilize the data within the AI-enabled applications.

## RELATED RESEARCH

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- *Worldwide Artificial Intelligence Market Forecast, 2019-2023* (IDC #US45332319, forthcoming)
- *Worldwide Artificial Intelligence Software Platforms Forecast, 2019-2023* (IDC #US44170119, June 2019)
- *Worldwide Artificial Intelligence Software Platforms Market Share, 2018: Steady Growth - Moving Toward Production* (IDC #US45262419, June 2019)
- *IDC's Forecast Scenario Assumptions for the ICT Markets and Historical Market Values and Exchange Rates, 4Q18* (IDC #US43652019, April 2019)
- *Technical Innovations Poised to Fuel AI Adoption for Enterprises* (IDC #US44974619, April 2019)
- *IDC's Worldwide Artificial Intelligence Taxonomy, 2019* (IDC #US45013419, April 2019)
- *IDC Market Glance: Artificial Intelligence, 1Q19* (IDC #US44808719, February 2019)
- *IDC FutureScape: Worldwide Analytics and Artificial Intelligence 2019 Predictions* (IDC #US44389418, October 2018)

## About IDC

International Data Corporation (IDC) is the premier global provider of market intelligence, advisory services, and events for the information technology, telecommunications and consumer technology markets. IDC helps IT professionals, business executives, and the investment community make fact-based decisions on technology purchases and business strategy. More than 1,100 IDC analysts provide global, regional, and local expertise on technology and industry opportunities and trends in over 110 countries worldwide. For 50 years, IDC has provided strategic insights to help our clients achieve their key business objectives. IDC is a subsidiary of IDG, the world's leading technology media, research, and events company.

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