Artificial Intelligence:
10 Trends to Watch in 2017 and Beyond

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SECTION 1

INTRODUCTION

Few technologies have the transformative potential to reshape how we live, move, and work. Electricity and the Internet were two technologies that fundamentally transformed life in the 20th century. Artificial intelligence (AI) is the 21st century equivalent of electricity and the Internet. AI is expected to bring massive shifts in how people perceive and interact with technology, with machines performing a wider range of tasks, in many cases doing a better job than humans.

AI, in its simplest definition, is an umbrella term for technologies that are inspired by biological systems, giving computers human-like abilities related to seeing, reasoning, hearing, and learning. The definition of AI is also a moving target; what is considered AI today, once successfully adopted and implemented, will no longer be considered AI. Today, AI encompasses technologies like machine learning, deep learning, natural language processing (NLP), computer vision, machine reasoning, and strong AI.

Tractica has conducted an analysis of the AI market by assessing approximately 200 use cases in which AI is being used currently, or will be in the near future. This bottom-up approach provides a comprehensive view of where AI is today, and its future trajectory. Tractica’s analysis of the AI market indicates that the technology is already deeply embedded in our lives, and its capabilities are growing at an exponential rate. There is a degree of hype around AI, but at the same time, it is a mistake to brush off the hype as a precursor to another AI winter.

This white paper presents the top 10 AI market trends to watch in 2017 and beyond, backed by data from Tractica’s bottom-up forecast model. While many of these trends are well-recognized by industry participants, some are surprising and challenge mainstream thinking about the AI market opportunity. The key trends examined in this paper are as follows:

- AI implementations will be focused on incremental improvements in the short term, but its transformative potential should not be ignored
- Virtually all AI implementations will be narrow AI
- Deep learning will be the most important AI technology
- Semi-supervised AI will gain traction
- A top-heavy and long-tail ecosystem is emerging for AI
- The era of GPU dominance in the AI market will end
- AI will impact almost every industry
- Human perception is a bigger driver for AI than Big Data
- Professional services is the next big emerging opportunity in AI
- AI czars will be part of government by 2020
SECTION 2

10 KEY AI MARKET TRENDS TO WATCH

2.1 AI IMPLEMENTATIONS WILL FOCUS ON INCREMENTAL IMPROVEMENTS IN THE SHORT TERM, BUT ITS TRANSFORMATIVE POTENTIAL SHOULD NOT BE IGNORED

AI is a powerful change agent and is gaining traction across multiple industries. However, going into 2017, the primary focus will be on using AI to make tactical, incremental improvements to key components of larger processes that can move the needle in terms of cost reduction, efficiency gains, and accuracy improvement.

AI can be seen as an extension of the data analytics trend that has been slowly percolating in different industries ranging from manufacturing, healthcare, and logistics to government and the military. Over the last few years, the value of Big Data has gained prominence, leading to the development of data analytics teams within companies, especially within Fortune 500 companies. The focus has been on identifying data sources, gathering the data, storing it, cleaning it, and using traditional statistical tools to make sense of these Big Data sets. The algorithms and models that have been applied to the data have been both machine learning (AI) and data mining techniques, with data mining being used to extract information from data, while machine learning is about understanding the properties of the data and making predictions from it, or classifying it into useful buckets, or going one step further in making associations between different data points.

Tractica’s Artificial Intelligence Market Forecasts report examines 191 use cases that are being deployed today or will begin deployment in the 2017 to 2018 timeframe. The majority of use cases take existing processes like predictive maintenance, anomaly detection, algorithmic trading, customer service, search engine queries, or cybersecurity threat detection and apply machine learning techniques or other AI techniques that can adapt rules and provide better results than previous static rule techniques. At the same time, AI is also enabling new capabilities like image classification or natural language understanding, which are being plugged into photo storage solutions, or into virtual digital assistants (VDAs). The majority of the new capabilities around vision and language are new, and are being offered as incremental improvements to consumer products and services using a freemium model, rather than creating new disruptive business models.

However, businesses need to prepare for AI fundamentally changing business processes and business models in the next 5 to 10 years, as organizations that act quicker and are more agile will have an edge. One area that is likely to produce new business models and enable major business transformation is that of NLP, with machines able to understand and converse with humans. Amazon Echo is a good example of how voice is becoming a platform, both for e-commerce and as a compelling user interface. In the enterprise context, AI will become a real-time decision engine, informing businesses and management teams about how to adapt and innovate. This will be a fundamental shift, with AI moving from being an automation engine that improves business processes to becoming a decision engine, providing real-time predictions and decision scenarios for companies that can choose the right strategy and outperform competition.

AI leaders within enterprises should start laying the groundwork to prepare for this shift, working with C-level and mid-level management to align business goals with decision engine functionality, and starting to break down the barriers between different data sets. Successful AI leaders will be those who are good at technology implementation as a starting point, but
more importantly can build trust and an effective working relationship between AI systems and the human decision makers. Part of this trust is dependent on the transparency of AI algorithms, which for deep learning are mostly black boxes in today's world. The big challenge for AI leaders within enterprises is finding the right balance of complexity, performance, and transparency for deep learning implementations, in a combination that will ultimately enable highly effective and productive decision engines.

2.2 Virtually All AI Implementations Will Be Narrow AI

The vast majority of AI implementations will be in narrow AI, which essentially refers to AI techniques and algorithms that are used to solve specific problems, with the algorithm needing to be retrained and remodeled when applied across different problem domains. For example, AI techniques used for classifying cancer cells in a computed tomography (CT) scan will not be ideal for recognizing faces or objects in Google Photos. Similarly, AI algorithms that can understand and parse the English language are unlikely to perform well when used for Chinese or Spanish. In other words, there are no generalized AI algorithms for vision or language today that can perform on a wide variety of vision or language problem sets. The algorithms need tuning and feature engineering, and the models need to be trained for solving specific tasks within vision or language, or any other problem domain like algorithmic trading or anomaly detection.

Chart 2.1 Narrow AI versus Strong AI Cumulative Revenue Share, World Markets: 2016-2025

Most people expect strong AI to emerge when a set of techniques or algorithms will be able to solve any problem, across any domain. This means the same algorithm will be able to learn from real-world data on the fly, whether it is vision, language, or Internet of Things (IoT) data, and then recreate new models that will be able to provide AI outputs. It is unclear what the time horizon looks like for that to occur, but this generalized definition of strong AI could be decades away.
On the other hand, a handful of companies like Vicarious and Google’s DeepMind are trying to solve strong AI in specific domains like game playing or vision. DeepMind developed AlphaGo, which is the set of algorithms and techniques that helped beat the best human Go player in the world. DeepMind hopes to develop a generalized version of AlphaGo, which will then be able to play any game, whether it is Go, chess, Atari, or StarCraft. DeepMind has recently partnered with Blizzard Entertainment to make the popular online multiplayer game, StarCraft II, an AI research platform. DeepMind’s long-term goal is to develop generalized AI algorithms that can learn how to play any game, and use techniques like transfer learning to port the techniques learned in gaming into other complex real-world areas like healthcare.

Similarly, Vicarious is working toward strong AI for object recognition, where AI can learn with minimal or zero training, and can identify any object, still or moving, and gain a general understanding of the scene and the real-world physics, even making predictions about the movement of objects based on their physical attributes. This will have major implications for robotics or self-driving cars. Tractica believes that this kind of “specialized flavor” of strong AI, whether in game playing, vision, or language, is 10 years away from mass commercialization. In the meantime, expect the majority of focus and development to occur in narrow AI.

2.3 DEEP LEARNING WILL BE THE MOST IMPORTANT AI TECHNOLOGY

Deep learning is a branch of machine learning that has gained prominence over the last few years, primarily due to the drastic improvement in performance seen in areas such as image recognition and speech recognition. The big breakthrough with deep learning came in 2012 when Alex Krizhevsky, Ilya Sutskever, and Geoffrey Hinton from the University of Toronto won the ImageNet image classification competition where they achieved an order of magnitude reduction in error rates compared to previous years using a two-layer deep neural network (DNN). Also in 2012, Google saw a halving of its error rate for a cat recognition algorithm, with the algorithm able to identify cats by simply being fed 10 million cat videos from YouTube.

Deep learning is a form of machine learning that uses neural networks, which mimic how neurons behave in the brain. Deep learning consists of multiple layers of networks, one stacked over the other, with each layer of the network trained separately, breaking down the characteristics of the data into multiple parts and combining all the layers in the end to provide the output. Deep learning algorithms are very good at dealing with very large data sets, or a complex set of inputs, which have multiple features that can be used to identify the data. In any deep learning or machine learning model, the AI is trained on specific features of the data, which allows it to learn specific characteristics of the data and to make predictions or correlations. In the case of an image recognition or classification algorithm using deep learning, there could be millions of features that the model needs to account for or understand. In such instances, deep learning is known to provide better results, with the neural network learning about the features on its own, rather than having someone hand-engineer the features. One of the major benefits of deep learning has been the reduction in time and effort spent on feature engineering.
It is important to note that deep learning will increasingly be used in conjunction with other AI techniques such as machine learning, NLP, computer vision, or machine reasoning. Deep learning will come in handy for feature extraction steps, especially when handling large data sets. In a combination of deep learning and machine learning, one would use machine learning algorithms to perform basic clustering or regression learning types of tasks during which features of the data are handcrafted, while deep learning would be used on a larger or more complex set of data. For example, in the use case of content distribution on social media, machine learning algorithms could perform a basic clustering of the content types that need distribution, or use regression learning to identify the best social media channels for a specific type of content using historical data. But deep learning would perform a more rigorous analysis of the type of content, extract features from the video or image, and then perform machine learning to make suggestions for time of day, social media channels, geographies, demographics, etc.

It has been shown that the performance of deep learning neural network algorithms is directly proportional to the number of layers. As the number of layers in the network increase, the performance has been demonstrated to increase on a linear scale. This also means that the hardware required to process and train these algorithms grows in scale. As a result, the companies that have been pushing the performance of deep learning are also the ones that have high-performance computing (HPC) expertise, and the resources to devote to training these DNN algorithms. Companies like Google, Facebook, Microsoft, and Baidu have all been leading the field of deep learning, as they continue to build AI teams that specialize in both high-performance computing and algorithms.
2.4 **SEMI-SUPERVISED AI WILL GAIN TRACTION**

Today, the majority of machine learning is the supervised kind, in which the training data is labeled, making it easier for the algorithm to perform, but making it harder for humans to design and test these algorithms. For a database the size of ImageNet, which is known to have around 10 million images, each one hand labeled, it is a major expense of time, effort, and cost. The other alternative to supervised learning is unsupervised learning with the algorithm able to draw inferences and cluster data in similar groups to find hidden patterns. Unsupervised learning can also be used as an intermediary step to cluster and pre-process unlabeled data, before supervised learning can be applied.

Another technique blends supervised and unsupervised learning, with a portion of the data labeled, but for the rest of the data, the system makes guesses about the labels using associations. Google has developed one such technique, called Graph-based learning, which uses semi-supervised learning. Using its Knowledge Graph technology, which makes relation associations between words, Google is able to leverage the associations to replace the cumbersome task of labeling all of the data. Google is already using this technology for many of its products like question answering, reminders, visual object recognition, dialogue understanding, and smart email replies. Semi-supervised learning is expected to see increasing usage for very large data sets, where data labeling is an issue, especially around vision and language. Pure raw data applications, which rely on Big Data, such as predictive maintenance in a manufacturing setting, can also use semi-supervised learning.

2.5 **A TOP-HEAVY AND LONG-TAIL ECOSYSTEM IS EMERGING FOR AI**

Based on Tractica’s analysis of the AI market, taking into account nearly 200 use cases for AI, big technology players like Google, Facebook, Microsoft, and IBM will focus their attention on highly scalable use cases like image recognition or patient data processing, which provide the largest revenue opportunities or help enhance their existing products and services to gain a competitive edge. The larger players will drive the advancement in algorithms, and will continue to have an advantage with very large training data sets, coupled with specialized expertise in high-performance computing systems that are becoming a necessary prerequisite for running high-end AI algorithms. High-performance computing is directly correlated to Big Data and extensive training required for multi-layered deep learning networks that power many of the top-end AI use cases like predictive maintenance, algorithmic trading, or static image recognition. Tractica expects deep-pocketed technology companies or financial institutions to lead the top-heavy AI ecosystem, given their ability to invest in HPC or AI research.

On the other hand, there will be a much larger subset of long-tail, niche use cases that will be the domain of smaller startups and small and medium-sized enterprises (SMEs). The SMEs will focus on using or enhancing existing AI algorithms, many of which are becoming open sourced, and they will rely on using high-performance cloud services for training and inference, using relatively smaller data loads. The long tail of use cases suggests that there will be a much larger group of niche problem areas where AI is expected to add value; an area where startups and medium-sized companies can compete effectively with the bigger players. The long tail of SMEs targeting niche use cases also presents a significant opportunity for professional services companies that can provide services like algorithm development, training, cloud services, support, and maintenance.
2.6 THE ERA OF GPU DOMINANCE IN THE AI MARKET WILL END

Graphics processing units (GPUs) have been the dominant hardware platform for AI applications and will continue to drive advances in performance, especially for high-performance deep learning systems. At the same time, Tractica sees the emergence of alternative hardware platforms like field-programmable gate arrays (FPGAs), application-specific integrated circuits (ASICs), and specialized processor architectures as competing with GPUs on various combinations of performance, cost, and power consumption. Startups like Graphcore, Wave Computing, and Knupath are introducing new neural architectures customized for AI and deep learning applications. Established silicon vendors are, in some ways, constrained by their legacy silicon architectures, providing room for new startups in deep learning hardware. As AI algorithms change to account for applications like autonomous driving or personalized medicine with dynamic inputs, there is a case for having memory storage on the processor itself. The evolving nature of algorithms and workloads will determine what architecture is best suited for deep learning.

Processors will increasingly be “right-sized” to align capabilities and cost with specific workloads, and whenever possible, inference will be moved to edge devices for most applications. Inference in the AI context refers to using a trained model to make inferences or provide outputs on real-world data. This is usually done at the application or client end point, rather than on the server or cloud. Inference requires fewer hardware resources, and depending on the application, can be performed using a central processing unit (CPU) or non-specialized hardware. This could be FPGA, ASIC, digital signal processor (DSP), or other processor architectures. AI’s increasing use on mobile devices for image recognition and speech recognition raises an expectation that inference will move locally to the mobile device itself. Apple’s iPhone 7 already performs most of the sophisticated AI inference tasks...
related to image processing and image recognition on the mobile device itself, and Apple has made local neural network libraries available to app developers that can use pre-trained AI models to enhance their applications on the mobile device. The growing number of AI application end points, especially the increase of AI usage in mobile devices, will cause a decrease in GPU usage compared to CPU usage (including FPGA, ASIC, DSP, etc.).

Chart 2.4  
AI-Driven Hardware Revenue, GPU and CPU, World Markets: 2016-2025

<table>
<thead>
<tr>
<th>Year</th>
<th>GPU</th>
<th>CPU</th>
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</thead>
<tbody>
<tr>
<td>2016</td>
<td>$10,000</td>
<td>$5,000</td>
</tr>
<tr>
<td>2017</td>
<td>$12,000</td>
<td>$6,000</td>
</tr>
<tr>
<td>2018</td>
<td>$14,000</td>
<td>$7,000</td>
</tr>
<tr>
<td>2019</td>
<td>$16,000</td>
<td>$8,000</td>
</tr>
<tr>
<td>2020</td>
<td>$18,000</td>
<td>$9,000</td>
</tr>
<tr>
<td>2021</td>
<td>$20,000</td>
<td>$10,000</td>
</tr>
<tr>
<td>2022</td>
<td>$22,000</td>
<td>$11,000</td>
</tr>
<tr>
<td>2023</td>
<td>$24,000</td>
<td>$12,000</td>
</tr>
<tr>
<td>2024</td>
<td>$26,000</td>
<td>$13,000</td>
</tr>
<tr>
<td>2025</td>
<td>$28,000</td>
<td>$14,000</td>
</tr>
</tbody>
</table>

(Source: Tractica)

2.7  
AI WILL IMPACT ALMOST EVERY INDUSTRY

Today, a lot of the focus and investment in AI is around consumer applications like search, product recommendations, voice-based assistants, social media feed curation, music curation, and image recognition. One of the reasons why there is so much excitement around AI is because consumers have started to see the benefits of AI in web/mobile products and services. Whether it is Spotify trying to understand your musical tastes, Google’s search providing improved results, or Apple’s Siri helping you to turn off the lights, AI is the underlying layer in many of the everyday consumer services and applications that we take for granted. Another area that leads AI investment today is the defense industry, with AI used to develop better object identification, detection, classification, and targeting for military aircraft, ships, satellites, and drones. Other industries like healthcare, business services, manufacturing, and agriculture currently see limited AI usage. AI is still not a mainstream technology implementation for these industries.

By 2025, while the consumer and defense sectors will continue to be major AI markets, Tractica does not see any specific industries dominating the AI landscape. AI will expand its reach over almost every industry. Advertising, business services, finance and investment, media and entertainment, and healthcare are some of the key industries that are likely to see major transformations and opportunities. Tractica has identified 27 industries that are expected to see the impact of AI, with almost every industry being a billion dollar-plus market.
2.8 **HUMAN PERCEPTION IS A BIGGER DRIVER FOR AI THAN BIG DATA**

AI use cases can be categorized into three main areas: Big Data, vision, and language. Big Data refers to use cases like algorithmic trading, predictive maintenance, patient data processing, sensor data analysis (IoT), and sensor fusion that uses raw data in the form of sensor readings, market indicators, or healthcare data. Big Data use cases for AI have experienced an explosion in growth recently because there is a very large amount of data that is being generated, and more importantly, a larger portion of the data is being captured and digitized. While Big Data-related use cases will continue to drive AI adoption, the greatest longer-term potential lies with applications related to human perception, i.e., those that enable computers to interpret vision and language. When combined, vision and language have a bigger impact on AI than pure Big Data-related use cases. While there is a general understanding that AI advancements are driven by Big Data, the larger potential of AI is around that of human perception, and that of replicating or augmenting human abilities, including vision and language.
AI algorithms already surpass humans in terms of image recognition accuracy today, and the next frontier is language, where a recent breakthrough was made by Microsoft in voice recognition and transcribing. Google’s DeepMind has also used AI to create artificial voice systems that sound more human-like than ever before. Voice recognition is a leading application that is expected to transform business models, spawning new business models and use cases. One example of AI becoming good at understanding language is Amazon Echo, which is a voice-based assistant device that is creating a new economy of apps that use voice as the primary user interface. Although Amazon Echo was the first to really go for a platform approach, it is now being followed by Google Home (Google Assistant), Apple’s Siri, and Samsung’s Viv, which aim to humanize technology with voice-enabled interactions. The big breakthroughs in voice recognition have come with systems like Amazon Echo or Siri being able to recognize different accents, or being able to parse the human voice in noisy environments. While the ability to understand humans is improving, their ability to answer back with intelligent responses is still not perfect. Currently, voice-based systems are good at performing specific tasks, but cannot necessarily perform the role of human companions who can conduct intelligent dialogue. Intelligent dialogue-based AI assistants combined with sophisticated vision capabilities will give rise to a new breed of human-like robots.

Other areas that will benefit from improved language capabilities include contract analysis systems in the legal industry, text-based automated bots, many of which are being used for customer service interactions today, and text-based querying of images and video.

Table 2.1  Top 15 Use Cases and Market Opportunity Matrix

<table>
<thead>
<tr>
<th>Use Cases</th>
<th>Big Data</th>
<th>Vision</th>
<th>Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static image recognition, classification, and tagging</td>
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<td>X</td>
<td></td>
</tr>
<tr>
<td>Algorithmic trading strategy performance improvement</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Efficient, scalable processing of patient data</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predictive maintenance</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Object identification, detection, classification, tracking from geospatial images</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Text query of images</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Automated geophysical feature detection</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content distribution on social media</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Object detection and classification - avoidance, navigation</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Prevention against cybersecurity threats</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contract analysis</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Text-based automated bots</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Sensor data analysis (IoT)</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
2.9 **PROFESSIONAL SERVICES ARE THE NEXT BIG EMERGING OPPORTUNITY IN AI**

Investment in AI will drive major investment in supporting professional services that help companies and businesses take advantage of the new era of machine intelligence. Organizations with an information technology (IT), Big Data, data analytics, or professional services background are well positioned to take advantage of the AI services opportunity. Tractica sees five areas for AI-enabled professional services emerging. These include installation, training, customization, application integration, and support and maintenance. Some of these sub-categories for AI-driven services will be along the lines of what we have seen in the enterprise software domain; however, AI-driven professional services organizations need to understand some of the nuances around algorithms, data, training, inference, and skillsets. Tractica sees the emergence of the full stack of AI service companies ranging from providing machine learning algorithms, data capture services, implementation frameworks, hardware, and research. While professional service companies can model themselves around the workflow of implementing AI in an organization, from installation to support and maintenance, they will need to create internal silos of knowledge or partner with companies that are specialists around the AI stack, from algorithms to hardware and research.

**Chart 2.6 AI-Driven Services Revenue by Service Category, World Markets: 2016-2025**

(Source: Tractica)
AI Czars Will Be Part of Government by 2020

The societal impact of AI will continue to be a major focus in the coming years, including issues such as ethics, bias, the impact on jobs and the economy, and the dangers of AI. In 2016, a number of initiatives and strategic guidelines have been launched both by governments and by industry participants. In the United Kingdom, the Alan Turing Institute is planning to set up an ethics board in partnership with the U.K. government. The recent White House report entitled Preparing for the Future of Artificial Intelligence discusses how ethics should be part of the educational curriculum for AI, machine learning, computer science, and data science. Within the industry itself, a partnership has been formed between Google, Microsoft, IBM, Facebook, and Amazon that is dedicated to advancing research and best practices related to ethics, fairness, inclusivity, privacy, and interoperability of AI technology.

Europe has also seen legislative recommendations in the European Parliament for treating robots as humans, and how to handle legal situations where robots can cause harm, leading to compensatory provisions for the aggrieved party. The legislation also suggests that the greater the learning or AI capabilities of the robot, the lesser the owning party’s responsibility, allowing for obligatory insurance schemes and compensation funds.

Overall, it makes sense for governments to take the lead in setting guidelines in terms of the legal and societal implications of AI. Governments in the United States and Europe are already thinking along those lines, and governments in China, Japan and Korea will likely follow suit. Tractica believes that, by 2020, there will be AI czars within the leading developed countries where AI is expected to play a major role across consumer, enterprise, and defense industries. The main role of AI czars and their department will be to set regulation and provide guidelines around ethics, algorithmic bias, the impact on jobs, and the dangers of AI in defense. AI is primarily a decision making tool. Proper guidelines and transparency are needed when making those decisions, whether the decisions concern cancer diagnoses, self-driving cars, or military drones. AI is having such a transformative impact on society and on decisions concerning life and death, so it is only fair to have the government ensure that the development and implementation of AI is done with appropriate oversight.
### SECTION 3

**ACRONYM AND ABBREVIATION LIST**

<table>
<thead>
<tr>
<th>Acronym and Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artificial Intelligence</td>
<td>AI</td>
</tr>
<tr>
<td>Application Specific Integrated Circuit</td>
<td>ASIC</td>
</tr>
<tr>
<td>Central Processing Unit</td>
<td>CPU</td>
</tr>
<tr>
<td>Computed Tomography</td>
<td>CT</td>
</tr>
<tr>
<td>Deep Neural Network</td>
<td>DNN</td>
</tr>
<tr>
<td>Digital Signal Processor</td>
<td>DSP</td>
</tr>
<tr>
<td>Field Programmable Gate Array</td>
<td>FPGA</td>
</tr>
<tr>
<td>Graphics Processing Unit</td>
<td>GPU</td>
</tr>
<tr>
<td>High Performance Computing</td>
<td>HPC</td>
</tr>
<tr>
<td>Internet of Things</td>
<td>IoT</td>
</tr>
<tr>
<td>Information Technology</td>
<td>IT</td>
</tr>
<tr>
<td>Natural Language Processing</td>
<td>NLP</td>
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<tr>
<td>Small and Medium-sized Enterprise</td>
<td>SME</td>
</tr>
<tr>
<td>Virtual Digital Assistant</td>
<td>VDA</td>
</tr>
</tbody>
</table>
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SECTION 6

SCOPE OF STUDY

This white paper examines 10 key AI market trends that Tractica has identified as part of its ongoing analysis of the commercial opportunity for AI. This white paper is not intended to be a complete summary of Tractica’s AI research findings, but describes 10 specific trends that will be key to understanding how the industry landscape and value chain will evolve in the coming years. Forecasts included in this report are from Tractica’s Artificial Intelligence Market Forecasts report, based on a bottom-up model of 191 use cases, across 27 industries, covering a 9-year time period between 2016 and 2025.

SOURCES AND METHODOLOGY

Tractica is an independent market research firm that provides industry participants and stakeholders with an objective, unbiased view of market dynamics and business opportunities within its coverage areas. The firm’s industry analysts are dedicated to presenting clear and actionable analysis to support business planning initiatives and go-to-market strategies, utilizing rigorous market research methodologies and without regard for technology hype or special interests including Tractica’s own client relationships. Within its market analysis, Tractica strives to offer conclusions and recommendations that reflect the most likely path of industry development, even when those views may be contrarian.

The basis of Tractica’s analysis is primary research collected from a variety of sources including industry interviews, vendor briefings, product demonstrations, and quantitative and qualitative market research focused on consumer and business end-users. Industry analysts conduct interviews with representative groups of executives, technology practitioners, sales and marketing professionals, industry association personnel, government representatives, investors, consultants, and other industry stakeholders. Analysts are diligent in pursuing interviews with representatives from every part of the value chain in an effort to gain a comprehensive view of current market activity and future plans. Within the firm’s surveys and focus groups, respondent samples are carefully selected to ensure that they provide the most accurate possible view of demand dynamics within consumer and business markets, utilizing balanced and representative samples where appropriate and careful screening and qualification criteria in cases where the research topic requires a more targeted group of respondents.

Tractica’s primary research is supplemented by the review and analysis of all secondary information available on the topic being studied, including company news and financial information, technology specifications, product attributes, government and economic data, industry reports and databases from third-party sources, case studies, and reference customers. As applicable, all secondary research sources are appropriately cited within the firm’s publications.

All of Tractica’s research reports and other publications are carefully reviewed and scrutinized by the firm’s senior management team in an effort to ensure that research methodology is sound, all information provided is accurate, analyst assumptions are carefully documented, and conclusions are well-supported by facts. Tractica is highly responsive to feedback from industry participants and, in the event errors in the firm’s research are identified and verified, such errors are corrected promptly.
CAGR refers to compound annual growth rate, using the formula:

\[ \text{CAGR} = \left( \frac{\text{End Year Value}}{\text{Start Year Value}} \right)^{\frac{1}{\text{steps}}} - 1. \]

CAGRs presented in the tables are for the entire timeframe in the title. Where data for fewer years are given, the CAGR is for the range presented. Where relevant, CAGRs for shorter timeframes may be given as well.

Figures are based on the best estimates available at the time of calculation. Annual revenues, shipments, and sales are based on end-of-year figures unless otherwise noted. All values are expressed in year 2016 U.S. dollars unless otherwise noted. Percentages may not add up to 100 due to rounding.
SECTION 7
ADDITIONAL READING

Tractica’s Artificial Intelligence Advisory Service examines use cases and business models for the application of artificial intelligence technologies in enterprise, consumer, and government markets. Research focus includes analysis of technology trends that are driving the development of more robust cognitive technologies, the use cases and value propositions for artificial intelligence in specific industries, and the key industry players who are shaping the next stage of market evolution. Granular market sizing, segmentation, and forecasting models provide industry participants with an objective assessment of the business opportunity for artificial intelligence software, as well as the hardware and professional services that will enable the software deployments.

Artificial Intelligence for Enterprise Applications

_Deep Learning, Machine Learning, Natural Language Processing, Computer Vision, Machine Reasoning, and Strong AI: Global Market Analysis and Forecasts_

Published 3Q 2016

[https://www.tractica.com/research/artificial-intelligence-for-enterprise-applications/](https://www.tractica.com/research/artificial-intelligence-for-enterprise-applications/)

This Tractica report examines the market trends and technology issues surrounding video analytics technologies and presents forecasts for hardware, software, and services during the period from 2015 through 2022. The report presents in-depth analysis of market drivers, market barriers, application markets, and technology issues, in addition to detailed profiles of 20 key industry players. Key application markets covered include retail, transportation, consumer, city, critical infrastructure, and enterprise. Market forecasts, segmented by world region, include hardware unit shipments as well as hardware, software, and services revenue.

Artificial Intelligence Market Forecasts


Published 3Q 2016

[https://www.tractica.com/research/artificial-intelligence-market-forecasts/](https://www.tractica.com/research/artificial-intelligence-market-forecasts/)

This Tractica report provides a quantitative assessment of the market opportunity for artificial intelligence across the consumer, enterprise, and government sectors. The report includes market sizing, segmentation, and forecasts for 191 specific AI use cases and the 27 industries in which they will play a role. The market forecasts span the period from 2016 through 2025 and include segmentation by the six fundamental AI technologies: machine learning, deep learning, computer vision, natural language processing, machine reasoning, and strong AI. Revenue forecasts are further segmented by software, hardware, and services in addition to segmentation by world region.
Video Analytics

*Smart Cameras, Software, and Services for Retail, Transportation, Consumer, City, Critical Infrastructure, and Enterprise Applications: Global Market Analysis and Forecasts*

Published 3Q 2016

[https://www.tractica.com/research/video-analytics/](https://www.tractica.com/research/video-analytics/)

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Virtual Digital Assistants

*Virtual Agents, Chatbots, and Virtual Assistants for Consumer and Enterprise Markets Utilizing Artificial Intelligence, Natural Language Processing, and Conversational User Interfaces*

Published 3Q 2016


This Tractica report examines the global market opportunity for consumer and enterprise VDAs, providing market sizing and forecasts for active users and revenue for the period from 2015 through 2021. The report includes an analysis of market drivers and barriers, use cases, technology issues, and key industry players. The VDA device and access types assessed in the study include smartphones, tablets, smart watches, fitness trackers, PCs, smart home devices, and automobiles.

Computer Vision Technologies and Markets

*Hardware and Software for Automotive, Sports & Entertainment, Consumer, Robotics & Machine Vision, Security & Surveillance, Agriculture, Retail, and Medical Markets: Market Analysis and Forecasts*

Published 3Q 2016


This Tractica report examines the market dynamics, technology issues, and business opportunities surrounding computer vision technologies and provides market forecasts for computer vision hardware and software during the period from 2015 through 2022. Eight application markets are analyzed in depth, and 27 key industry players are profiled. Market forecasts, segmented by world region and application market, include hardware unit shipments and revenue, device pricing, and software and services revenue.
Natural Language Processing

*Media, Retail, Healthcare, Advertising Technology, Education, Automotive, and Other Enterprise Applications for Natural Language Processing Software and Systems: Global Market Analysis and Forecasts*

Published 1Q 2016

[https://www.tractica.com/research/natural-language-processing/](https://www.tractica.com/research/natural-language-processing/)

This Tractica report examines the market trends and technology issues surrounding natural language processing and presents 10-year forecasts for NLP hardware, software, and services during the period from 2015 through 2024. Current and potential applications are analyzed in depth, and the report also includes detailed profiles of 20 key industry players. Market forecasts, segmented by world region, include projections of software, hardware, and services revenue across 15 different industry sectors.

Deep Learning for Enterprise Applications

*Advertising Technology, Financial Services, Media, Manufacturing, Oil & Gas, Retail, and Other Enterprise Markets for Deep Learning Software and Systems*

Published 4Q 2015

[https://www.tractica.com/research/deep-learning-for-enterprise-applications/](https://www.tractica.com/research/deep-learning-for-enterprise-applications/)

This Tractica report examines the market for deep learning across 15 industry sectors, including 10-year revenue forecasts for the period from 2015 through 2024. The report forecasts software revenue, services revenue, and hardware sales, and provides segmentation by delivery method (cloud, device, and data center) as well as world region. The report also includes profiles of 20 key industry players in the global deep learning market.

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AI Summit attendees may receive a 20% discount off standard pricing of Tractica’s AI research reports by contacting Tractica and mentioning the AI Summit. Please see the back page for contact information.
SECTION 8
THE AI SUMMIT

AI is already here. It’s being implemented in most industries by leading organisations spanning finance, law, healthcare, manufacturing, transport, energy, education and many more.

The AI Summit is the world’s first and largest conference & exhibition to look at the practical implications of AI for enterprise organisations, the actual solutions that are transforming business productivity.

Supported by the leading AI solution providers, including Founding Partners Amazon, Digitate, IBM Watson and Microsoft, The AI Summit New York gathers 350+business CxOs, AI start-up innovators, press/media and acclaimed researchers.

The AI Summit is unique among AI events, specifically geared towards corporate CxOs:

• **Thoroughly researched conference programme** with engaging, inspiring CxO speakers and exclusive case studies

• **Unrivalled seniority of audience** with the most senior decision makers of the world’s largest businesses

• **Refreshing event experience** with live entertainment throughout and VIP invitation-only dinners at Michelin-starred restaurants

• **Tailor-made AI-powered networking tools** enhanced by our VIP Concierge services that help forge lasting connections with industry peers

• **Comprehensive exhibition** with all of the industry’s major leaders launching and promoting their latest AI solutions and products at The AI Summit

The next AI Summit is being held in New York City on December 1, 2016. For more information, visit www.theaisummit.com/newyork

To see the full 2017 program of AI Summit events in London, San Francisco, New York, Tokyo, Hong Kong and beyond, please visit www.theaisummit.com

Join us for an insightful, engaging and rewarding event experience that opens up the intelligent world of opportunities!
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