Artificial intelligence and machine learning offer the potential to reinvent business models, ecosystems and customer experiences but can't yet match the breadth of human intelligence. Enterprise architecture and technology innovation leaders who use open innovative approaches will make big gains.

Key Findings

- Enterprise architecture (EA) leaders are recommending machine learning to their organizations. This is because of the explosion of new information sources, the miniaturization of and increases in compute power, the open availability of machine-learning tools, and new and advanced algorithms.

- Leading organizations place strong emphasis on information architecture as a foundational requirement in their artificial intelligence (AI) and machine-learning initiatives to identify and apply algorithms that maximize business outcomes. In parallel, they create plans to avoid pitfalls and limitations.

- Nearly all industries have some machine-learning implementations for enabling business scenarios. These span customer engagement, digital production, smart cities, self-driving cars, risk management, computer vision, and language and speech recognition.

- Throughout 2019, enterprises will consume deep learning mainly through the integration of cloud-based AI and machine-learning business applications, devices or APIs.

Recommendations

EA and technology innovation leaders using EA to master emerging and strategic trends:

- Work with business and HR leaders to create or integrate a machine-learning-focused competency-driven strategy that can attract and retain top AI talent to stay competitive.
Use EA to devise five to 10 viable business scenarios during the next six months inspired by AI and machine learning.

Address the cultural, social and ethical challenges that will arise as a direct result of machine learning by developing social and ethical roadmaps as impact analysis tools. These challenges will include the changing relationship between technology and human beings, the displacement of knowledge workers, and tests of existing compliance laws.

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Strategic Planning Assumption

Throughout 2019, enterprises will consume deep learning mainly through the integration of cloud-based AI and machine-learning business applications, devices or APIs.

Analysis

Why Artificial Intelligence and Advanced Machine Learning Is a Top 10 Trend

AI and advanced machine learning are much-talked-about emerging technologies that could revolutionize businesses and even entire industries. They have the ability to drastically reduce labor
costs, generate new and unexpected insights, discover new patterns, and create predictive models from raw data.

We've chosen AI and advanced machine learning as one of our top 10 strategic technology trends because leading organizations are using them to drive next-generation solutions.

The five key market forces driving adoption of AI and advanced machine learning in 2017 and beyond are:

1. **Overwhelming demand.** The volume of inquiry calls from Gartner clients about AI, advanced machine learning and related topics increased by 200% between 2015 and 2016. This shows strong demand for information on AI, advanced machine learning, and topics such as smart machines and bots. Clients want to know what is possible with technology adoption.

2. **Smart everything.** In 2016, we saw unprecedented progress with AI and advanced machine learning. This covered real-world applications, including healthcare diagnoses, predictive maintenance, legal applications, customer service, digital oil fields, automated data centers, self-driving cars and smart homes.

3. **Heated competitive landscape.** AI will be the main battleground for cloud providers through 2020. In 2016, many companies — such as Amazon, Google, Microsoft, Oracle, SAP and Salesforce — declared AI as their top strategy. In the next few years, almost every service provider will be introducing AI and advanced machine learning into their core strategy.

4. **Harnessing of Internet of Things (IoT) data.** The volume and velocity of data from IoT sources will drive the need to automate development of actionable insight using tools such as AI and advanced machine learning. By 2020, 20% of enterprises will employ dedicated people to monitor and guide machine learning (such as neural networks). The notion of training rather than programming systems will become increasingly important.

5. **Ability to talk back.** Natural-language processing algorithms are continuously advancing. AI is becoming more proficient at understanding spoken language and at facial recognition, enabling it to provide a much more useful and conversation-based solution. These algorithms are progressing in unexpected ways, as Google found when Google Translate invented its own language to help it translate more effectively.

Although some of the advancements in advanced machine learning are the result of the use of machine-learning algorithms, many of the key drivers (see Figure 1) are the result of these enabling technologies, information, connectivity and raw compute power.
The following key drivers make AI and advanced machine learning a top 10 strategic technology trend:

- **Information explosion**: The number of sources of information to which machine-learning technology has access is growing all the time. These sources include sensors and other edge computing devices. This means that machine-learning technology can now access the essential data to fuel its algorithms.

- **Increases in, and miniaturization of, compute power**: Advanced system architectures, in-memory storage, and more powerful and efficient chipsets in a highly scalable cloud-based architecture are now available (see "Top 10 Strategic Technology Trends for 2016: Advanced System Architecture"). This has removed many of the infrastructure implementation inhibitors for organizations, making machine-learning solutions vastly more powerful and affordable.

- **Availability and ubiquity**: Software development tools were once prohibitively expensive and complex, but have become relatively inexpensive or even free, and researchers now have the opportunity to work with them.
Advanced algorithms: Machine-learning algorithms consist of a set of many technologies, including deep learning, ensemble techniques, simulations and optimization techniques, and natural-language processing. Hundreds of thousands of data scientists apply these techniques daily to solve business problems and a further 100,000 students are working in data science and related disciplines.

Where Artificial Intelligence and Advanced Machine Learning Fits in the Top 10

This trend is part of the intelligent theme (see Figure 2), along with intelligent apps and intelligent things. The intelligent theme builds on the way in which data science and programming approaches are evolving to include AI and advanced machine learning. This is enabling the creation of intelligent physical and software-based systems that are programmed to learn and adapt, rather than programmed only for a finite set of prescribed actions. AI and machine-learning capabilities are seeping into almost every technology, and represent a major battleground for technology providers over the next five years.
AI and Advanced Machine Learning Focus on Well-Scoped Purposes

AI and advanced machine learning offer exciting possibilities, but can’t yet match the human brain’s breadth of intelligence and are still a long way from offering general-purpose intelligence. Instead, they focus on well-scoped purposes.

AI and advanced machine learning excel at dealing with high degrees of complexity, forms, and volumes of data to understand, learn, predict and then adapt, enabling them to act in ways that weren’t explicitly programmed. They mark a shift from an explicit programming model to a more implicit programming model with feedback loops. This enables them to start acting autonomously. Data science is evolving, moving into predictive analytics and these new learning systems.
These narrow AI or well-scoped machine-learning technologies bring transformative capabilities, enabling organizations to be successful in the future. The following cross-industry business scenarios highlight the many possibilities of machine learning (for more examples, see "Machine Learning Drives Digital Business"):

- **Retail product recommendations**: Machine learning can pull disparate information sets from online purchase histories, product likes and dislikes. It can use everything from eye-gazing technologies in retail stores to sensory data from smartphones. It can use these to create propensity-to-buy models that predict which product a customer is most likely to buy.

- **Dynamic insurance pricing**: Insurance organizations can create prediction models based on the conditions of a specific market, such as housing bubbles, historical sales, natural disasters, a surge of burglaries, or opted-in sharing of the consumer’s data. These models can dynamically adjust insurance rates.

- **Online risk mitigation in hospitality**: As new business ecosystems emerge and redefine industries, such as hospitality, the defrauding of those ecosystems and their communities becomes an increasing risk. Companies such as Airbnb use machine learning to create risk models to protect their customers.

- **Optimized lending**: Machine-learning solutions can map a loan applicant’s details (such as demographics, as well as credit and payment history) to predict the likelihood that the applicant will default on a loan.

- **Retail banking fraud detection**: Algorithms can be created to assess and model current real-time transactions, as well as predictive models of transactions based on their likelihood of being fraudulent.

- **Real-time decisioning by city utilities**: Machine learning can create probabilistic models from, for example, wind turbines, solar panels and soil actuators to predict when failures will occur. This enables utilities to dynamically redirect power or water, decrease maintenance costs and minimize downtime.

- **Medical diagnostics**: Machine learning can provide doctors with a more accurate classification of a patient’s medical condition, including recommendations for therapy or treatment. It does this by assembling data from sources, including current vital signs, symptoms, home lab tests, or historical vital signs from algorithmic medical devices (for example, Eko Core).

- **Creation of safe working conditions**: Organizations with workers in potentially unsafe environments can use machine learning to detect early warning signs that may predict the likelihood of accidents. In this use, machine learning examines sensor data from the measurement of air quality, equipment performance, employee productivity and even atypical behavior.

- **Automated customer service**: People calling customer support are greeted with a virtual assistant that uses cognitive abilities to listen to customers (speech recognition) and maps to a guided training set and knowledge base, as shown by USAA.
Enhancement of the student experience: Deakin University in Australia is using IBM Watson to help students find information easily.8

What AI and Advanced Machine Learning Makes Possible

AI and advanced machine learning are model- and data-driven systems and suggest a trial-and-error approach. This marks a departure from the traditional rule-based method of developing that gives explicit directions in ever-finer detail and tells the system what to do. With AI and machine-learning systems, you hypothesize a model designed to meet a particular purpose and then let the model be adapted to the specific situations, as described by the data. Instead of explicitly defining the software logic, it will be synthesized from the data using a computationally intensive search process.

This is a new way of thinking about systems. You need to consider whether you have people who understand that. You also need to think about how you’ll train these systems. Sometimes these systems will make mistakes because they haven’t yet learned the correct response to certain information they’re receiving. These systems will go through feedback loops and learning cycles. You will build deep neural networks and inference engines and drive this to more of a context- and event-driven model. That’s a fundamental shift.

The field of AI and machine learning has continually evolved since it began in 1943.9 It encompasses many different models, approaches, and implementations, sparking a high degree of interest but also a high degree of confusion. AI and machine learning refers to systems that change behaviors without being explicitly programmed, based on data collected, usage analysis and other observations. We encourage clients to scrutinize the use of AI, focusing on exactly how a system "learns" without reprogramming.

AI technologies can ingest more data and detect (and predict) patterns more accurately than people can (at least in some cases). They don’t rely on solely growing insights through alterations in code or manually developed rules.

Not every organization will have teams writing models and doing deep neural network programming. Many organizations will buy these systems as packaged products that will embed AI, or as services such as Google Prediction API or IBM Watson that will package some of these algorithms, capabilities and frameworks. Often these services will be delivered only as cloud services.

AI and machine learning enable organizations to extend their applications and create new ones. They don’t replace all the programming that organizations have already done.

AI and Machine-Learning Algorithms

The following categories of algorithms have an extremely popular implementation base:

- Supervised learning: A set of pattern-seeking algorithms trained using methods such as classification, regression, prediction and gradient-boosting prediction. Algorithms in this category include:
Linear and logistic regression
- Ensemble techniques (including random forests)
- Deep or shallow neural nets
- Decision trees or support vector machines

**Unsupervised learning:** A set of algorithms that infers a conclusion or hidden structure used within unlabeled (unstructured) data with an unknown or yet-to-be-identified conclusion. Algorithms in this category include:
- Hierarchical clustering
- K-means clustering

**Reinforcement learning:** A set of trial-and-error-based algorithms that discovers which actions yield the highest return. Algorithms in this category include:
- Temporal difference learning
- Q-learning
- Learning automata

**Actions**

**EA and technology innovation leaders:**

**Use the machine-learning industry's body of knowledge:** Over the next 12 months, create five possible business scenarios in which your organization might use machine learning to achieve its future-state business outcomes. Consider experimenting with one or two of these scenarios. Seek inspiration from publicly available machine intelligence technologies by Microsoft, Google, Facebook or IBM to understand the competitive advantages your organization will gain if it adopts early.

**Protect your intellectual capital:** Partner with risk experts inside and outside your organization to understand the impacts of machine learning on your organization's intellectual property (see "Toolkit: Best-Practice Checklist for Intellectual Property Protection").

**Identify the data suitable for machine learning:** Not all data contains insights that will solve your problems. Suitable data could be a history of breakdowns or claims, or medical images that show tumors. Suitable data contains unique insights for your business, other businesses and partners.

**Address social and ethical challenges:** Create social and ethical roadmaps as impact analysis tools to understand the cultural, social and ethical challenges that will arise as a direct result of machine learning (see "Toolkit: What Enterprise Architects Need to Drive Computing-Everywhere Strategies"). These challenges will include the changing relationship between...
technology and human beings, the displacement of knowledge workers, and tests of existing compliance laws.

- **Devise a sustainable talent management strategy:** Create or integrate a competency-driven strategy to nurture and foster machine learning. This is vital to stay competitive and retain top talent in a rapidly changing and competitive algorithmic-based economy.

- **Examine your choices:** Consuming AI and advanced machine-learning solutions via APIs, SaaS or packaged applications will probably be sufficient. Usually there is no need to develop such solutions yourself.

- **Upskill yourself:** Machine learning and data science are not incredibly difficult. Take advantage of the available courses (such as those from Coursera and Udacity), experiment with open-source projects and use the many Gartner resources (for example, see "Doing Machine Learning Without Hiring Data Scientists").

### Appendix: The Other Top Strategic Technology Trends for 2017

For information on the other top strategic technology trends for 2017, see:

- "Top 10 Strategic Technology Trends for 2017: Intelligent Apps"
- "Top 10 Strategic Technology Trends for 2017: Intelligent Things"
- "Top 10 Strategic Technology Trends for 2017: Virtual Reality and Augmented Reality"
- "Top 10 Strategic Technology Trends for 2017: Digital Twins"
- "Top 10 Strategic Technology Trends for 2017: Blockchains and Distributed Ledgers"
- "Top 10 Strategic Technology Trends for 2017: Conversational Systems"
- "Top 10 Strategic Technology Trends for 2017: Mesh App and Service Architecture"
- "Top 10 Strategic Technology Trends for 2017: Digital Technology Platforms"
- "Top 10 Strategic Technology Trends for 2017: Adaptive Security Architecture"

### Gartner Recommended Reading

*Some documents may not be available as part of your current Gartner subscription.*

- "Predicts 2017: Artificial Intelligence"
- "Hype Cycle for Smart Machines, 2016"
- "Conversational AI to Shake Up Your Technical and Business Worlds"
Evidence

1 "Predicts 2017: Artificial Intelligence"


3 "Very Personal Finance," The Economist.


7 "USAA Taps IBM’s Watson as Military Veterans Advisor," eWeek.

8 "IBM Watson Helps Deakin Drive the Digital Frontier," Deakin University.


10 "Artificial Intelligence," Microsoft Research.


More on This Topic

This is part of an in-depth collection of research. See the collection:

- Top 10 Strategic Technology Trends for 2017: A Gartner Trend Insight Report
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