Executive Insights

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Are You Ready to Enter the AI Age?

Artificial intelligence (AI) is the technology revolution of our age. The global AI market is expected to experience exponential growth in the near future, driven by technological breakthroughs, favorable policies and regulations, and robust investments. How to transform our businesses and create value through AI is the key question for senior executives.

The AI market will approach $1T within a decade

AI has been a buzzword for many years. The industry has gone through several waves of ups and downs. However, more and more real-world AI applications have attracted interest and investment.

Despite being in its nascent stage of development, the AI market is expected to grow exponentially in the next decade with a CAGR of 64%, exceeding $1 trillion by 2027.

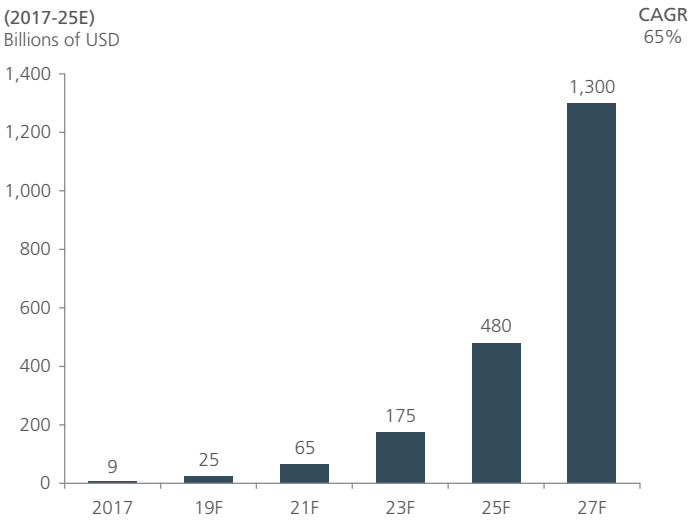
What are the key drivers of the AI market?

The boom in AI technology and the AI market is driven mainly by technology advancement, government policies and investor support.

Continuous improvement of deep learning algorithms, AI chips and big data availability drives AI technology innovation.

AI has evolved from academic research to the real-world application stage, and it has broken the limits of traditional computing technology by incorporating the most advanced technologies and systems. The maturation of cloud storage and computing technology has created the foundation for processing large quantities of images, text and other types of data. Unleashing AI capabilities will enable businesses to achieve transformation at once-unattainable levels.

Figure 1
Global AI Market Forecast



Source: L.E.K. analysis

Researchers have improved AI algorithms to achieve unprecedented levels of performance. The accuracy of audio and image recognition has significantly improved since 2012 and can beat human performance.

Are You Ready to Enter the AI Age? was written by **Yong Teng**, Partner, **Eric Wang**, Principal, **Lou Yiru**, Manager, and **Casper Ye**, Consultant, all from L.E.K. Consulting's Shanghai office.

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Open-source frameworks such as TensorFlow, Caffe, Neon, Torch, Theano and CNTK lower the barrier to developing deep learning algorithms. Big data provides sufficient learning material for algorithm training purposes. By 2020, the total length of online video uploaded per month globally is expected to be the equivalent of 5 million years — i.e., 1 million minutes of video will be uploaded each minute.

Improving hardware provides the foundation for deep learning algorithms. AI chips such as GPU, FPGA and ASIC (Application Specific Integrated Circuits, such as TPU and NPU) greatly improve the efficiency of AI training and inference. There is no doubt that new technology will keep fueling the AI revolution.

Supporting policies laid out by governments help guide the development of AI

Sensing the strategic importance of AI to national competitiveness, major countries have launched nation-level policies and government-sponsored programs to facilitate AI development.

China issued in January 2018 the Artificial Intelligence Standardization White Paper, which is a high-level development strategy for China's AI industry. In July 2017, it issued the Next Generation Artificial Intelligence Development Plan, setting up strategic goals, main tasks and supporting measures for AI development before 2030.

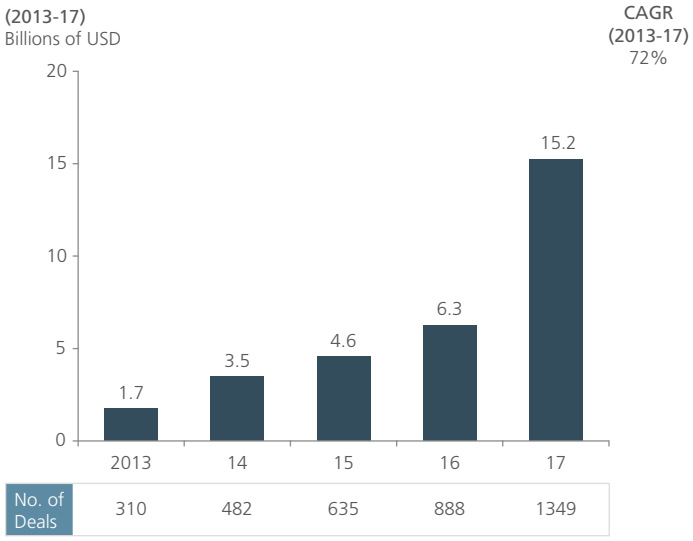
The United States published Artificial Intelligence, Automation, and the Economy in December 2016, focusing on the economics of AI-driven automation and recommended policy responses. In June 2016, the Subcommittee on Networking and Information Technology Research and Development (NITRD) announced the National Artificial Intelligence Research and Development Strategic Plan, a set of objectives for federally funded AI research.

Japan issued the 5th Science and Technology Basic Plan (2016-2020) to further promote the development of technologies for AI. The plan considers edge computing and high-speed processing devices as the fundamental technologies necessary to build the Super Smart Society Service Platform.

Significant investments provide resources to move AI from research to application.

By the end of 2017, AI startups had received $15 billion in investment, nearly 48% of which was in seed / angel series funding. In addition, global tech giants such as Google and Baidu spent between US $30 billion and US $40 billion on AI in 2017, with 90% spent on R&D and deployment, and 10% on M&A. Both strategic and financial investors are betting heavily on the AI industry.

Figure 2
Annual funding in artificial intelligence

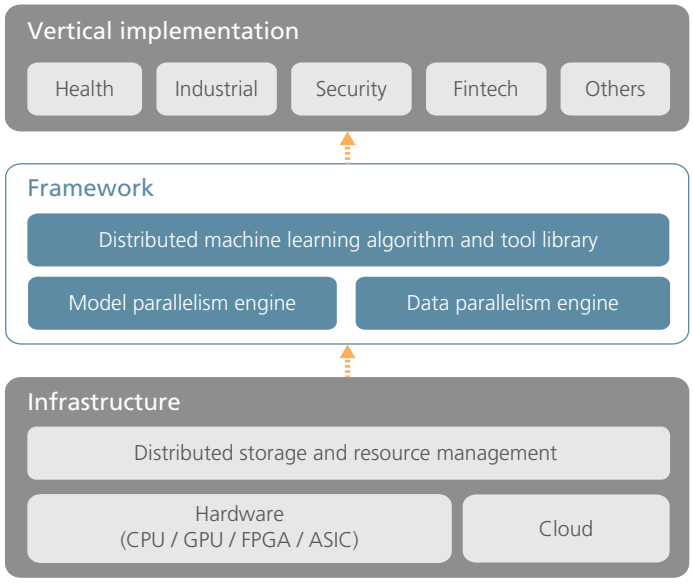


Source: CBInsights, L.E.K. analysis

How does AI work?

AI covers everything that imbues machines with "intelligence." Its architecture typically consists of hardware infrastructure, a framework of AI algorithms and vertical applications. These three components are built on top of each other and together support AI.

Figure 3
Artificial Intelligence Structure

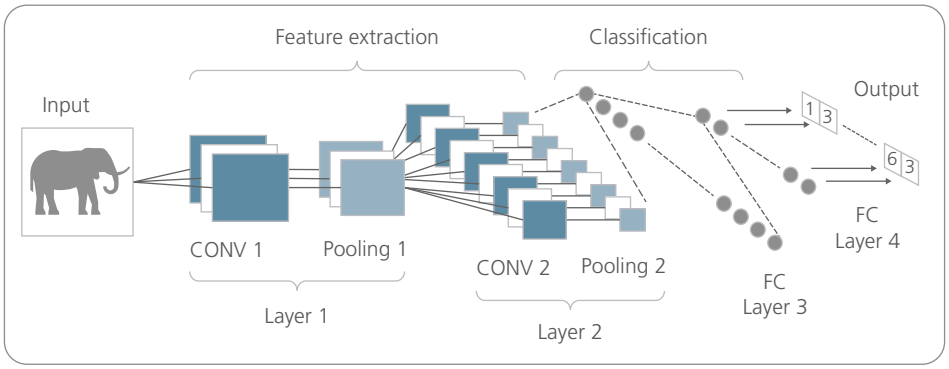


Source: L.E.K. analysis

Infrastructure

AI infrastructure is an essential foundation to scaling, accelerating, automating and managing the processing of a massive amount of data. As the back end of all applications, infrastructure also requires a scalable environment with expanding computing resources. The cloud is a major platform for data storage and computing, creating the foundation for dealing with large quantities of images, text and other types of data. Different types of processors balance computational efficiency with programmability. ASIC typically is the fastest, and CPU the most flexible. Enterprises must choose the right AI infrastructure for their needs.

Figure 5
Typical multi-layer Convolutional Neural Network

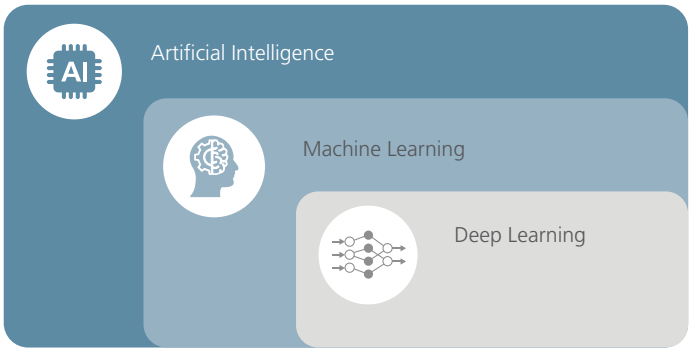


Source: L.E.K. analysis

Algorithm framework

AI consists of a wide range of algorithms / techniques. Machine learning is a statistical learning method designed to train models with large amounts of data to enable the "myth" of AI. The model "learns" the rules from known data and automatically updates the relevant parameters in the model. The trained 'rules' and 'models' are used to predict future in the real world.

Figure 4
Hierarchy of artificial intelligence concepts



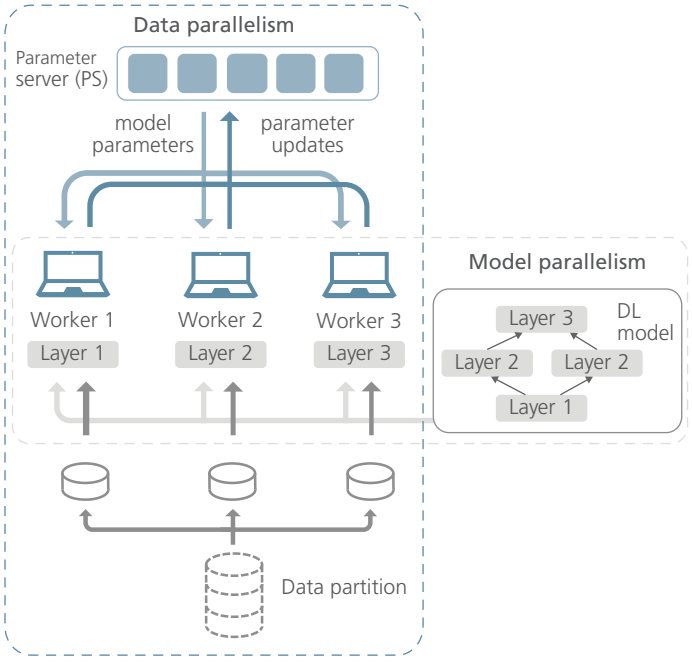
Source: L.E.K. analysis

Deep learning, which uses networks such as convolutional Neural Networks (CNNs), is a subfield of machine learning. It is widely used in image recognition, voice recognition and other fields and is based on a neural network algorithm that simulates the human nervous system by layering multiple (usually four, five or more) nonlinear functions.

With increasingly large data sets (greater than 1TB) and more complex models (with more than 100M parameters), the core competencies of an AI framework are computing power and training efficiency. Data parallelism and model parallelism are typically needed to create an edge in data processing.

In data parallelism, data is distributed across multiple processors (aka workers). Each worker gets a different portion of the data and trains the model. The key to data parallelism is putting the results together and synchronizing the model parameters.

Figure 6
Illustration of data and model parallelism



Source: L.E.K. analysis

In model parallelism, different machines in the distributed system are responsible for the computations in different layers of a network. For example, each layer in the neural network might be assigned to a different machine. The advantage of model parallelism is in speeding up an algorithm by updating multiple parameters concurrently.

Vertical applications

AI creates value through vertical applications. Successful vertical implementation requires a combination of AI and deep subject matter expertise to transform products into customized solutions / services. AI can be applied to a wide range of industries, such as healthcare, industrial, security and fintech.

What can AI do?

Through supervised learning, unsupervised learning and reinforcement learning, machines gain "intelligence" and perform like humans typically do.

Image recognition and Natural Language Processing (NLP) are two prime examples of practical applications. Supervised learning is now becoming accurate enough to use in business tasks.

AI can emulate human capabilities to learn, communicate, perceive and move. For example, chatbots such as DoNotPay use machine learning to interpret user responses and to determine follow-up queries. Voice commands based AI that are specific to services is expected to be within the realm of near-future capabilities. Detecting emotions and lies during depositions may become possible using voice recognition. Internal data analysis — to assist in optimizing the language of briefs and motions, for example — can be realized through machine learning.

In business, AI technology could improve productivity, encourage innovation and facilitate manual tasks.

What challenges do companies face when adopting AI?

Data availability, implementation complexity and value creation are what companies need to consider when adopting AI.

Data availability: The quantity and quality of data used to train the model are the bottleneck in many cases. AI model training is based on the prerequisite of sufficient historical or reference data. In most industries, there is not a tracking system to produce data, or it is difficult to even gain access to data. In other cases, the available data is either insufficient or not yet ready to be used in model training.

Implementation complexity: Although AI-as-a-platform services have emerged in some sectors (e.g., voice recognition, surveillance and image reading), it is very difficult to develop an industrywide or even cross-industry AI solution. A significant amount of customization work and domain knowledge are required. Expanding beyond one domain and scaling up rapidly are significant hurdles.

Value creation: The application of AI technology should bring the company real value or a tangible competitive edge. AI technology is expected to be seen first in areas with the most direct and quantifiable benefits, such as

- Revenue generation: recommendations to customers
- Cost savings: workflow efficiency improvement, detection of anomalies in the workflow
- A tangible competitive edge: AI-empowered imaging equipment, financial investment decisions, etc.

How should enterprises get ready for the AI revolution?

First of all, management should decide where and how AI technology will be adopted. They should evaluate the short-term and long-term value of the AI use cases and the corresponding financial impacts.

Second, companies should assess their internal IT capabilities and infrastructure. These vary significantly across industries, and it would simply not be efficient for traditional industries or small-scale companies to close the gaps on their own. Companies should carefully evaluate how and at what levels they should introduce external partners, including but not limited to cloud service platforms, solution providers and system integrators.

Finally, a clear implementation road map and performance-tracking mechanism should be developed jointly by the key stakeholders. Management should emphasize the importance of the project and allocate sufficient resources to ensure the desired outcome and on-time delivery.

What is the supplier landscape of AI?

A rising number of players have tapped into the AI market, with different focuses.

Integrated players: The AI ecosystem comprises infrastructure, frameworks and vertical implementation. IT giants such as Google, Amazon and Baidu have integrated value chains.

They are the leaders in the AI market, with a wide range of products and services from cloud computing platforms to AI frameworks and AI end products.

Chip suppliers: Some players focus on AI chips, which are the foundation of AI infrastructure. Integrated Chip (IC) giants such

as Intel, Qualcomm and NationalChip (杭州国芯) are still the leaders in AI chips market. A few startups, such as Cambricon (寒武纪), DeepcreatIC (深思创芯科技) and IME (中国科学院微电子研究所), are emerging as major competitors of AI chips. They entered the market with academic backgrounds and often gain support from universities / research institutes.

Algorithm and framework suppliers: There are quite a few emerging leaders competing with the integrated players. Taking SenseTime (商汤科技) as an example, it has a well-developed system of algorithm framework, which are proven in applications in facial recognition and in the education, retail and automotive industries.

Application providers: There are an increasing number of specialized AI companies focusing on applications targeting specific industries. IFlyTek (科大讯飞) and iCarbonX (碳云智能) are two such examples.

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