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**Review Article**

# **Deep Learning Applications in Business Activities**

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**Abstract:** With huge improvement of computer calculation abilities, deep learning method have great potential applications in wider business fields. With the data provided by many companies, deep learning method has achieved great success in the aspect of reducing expense of companies' activities, and brought unexpected profits. This article explains the basic principles of deep learning, introduce its main scope of application, and explore its application in business. This article provides a more pertinent assessment by querying the data and relevant reports of the enterprises engaged in this work. This article introduces and explain the mathematical equations for the deep learning, and discuss about different types of Neural Network including Feed-forward Neural Networks and Recurrent Neural Networks. Based on the types of deep learning model, this article demonstrates the applications of deep learning method in business activities based on concrete examples. The applications include Customer Service, Sales, Marketing, Daily Operation and Risks Management. Through the relevant queries, this article indicates a lot of convincing data and examples to prove that deep learning in business activities has a good effect. This is instructive and helps business practitioners to consider a new and more effective way to increase revenue or save costs. Through the relevant queries, this article found a lot of convincing data and examples to prove that deep learning in business activities has a good effect. Studying from the principle of deep learning to the applications in real business situation, deep learning is coherently introduced to the audience.

**Keywords:** Deep Learning, Business, Neural Networks

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## **1. Introduction**

Deep learning is a form of machine learning that enables computers to learn from experience and understand the world in terms of a hierarchy of concepts. Since the term of "Deep Learning" was first introduced by Rina Dechter to the field of machine learning in 1986, it received extensive attention from many fields. [1]

As a part of machine learning, deep learning has its own distinct demerits. One of its outstanding advantages is that it can commendably dealing with complex work that may be hard to achieve by other techniques. On the other hand, it requires massive sets of data and advanced computer hardware to operate. [2] While in many fields nowadays, big data is easy to obtain, meanwhile the development of technology provides more powerful computers. Therefore, overcoming the shortcoming of deep learning, exceptional

outcomes can be created in many fields utilizing its virtues.

As mentioned above, deep learning can be applied in complicated models which cannot be achieved by any other learning algorithms, it is widely used in fields like image identification, Pilotless driving and natural language recognition. [3] The main ideas in the applications of the deep learning are all similar — use a large scale of data as simple to train the model then applied the finished model to perform predictions. [4] Therefore, it is obvious that deep learning has a hopeful application prospect in many fields.

In modern business activities, companies always face vast and irregular data in their daily operation while huge business opportunities may be hidden behind. Either companies do not know how to extract useful information out of such data, or employees waste their time on some repeated work. Both of the issues can be solved by deep learning. It can analyze historical data to conceive new perspective or replace human

in reduplicative work to lower human cost. In other words, deep learning injects vigor into business activities, and some

achievements can already be seen. [5]

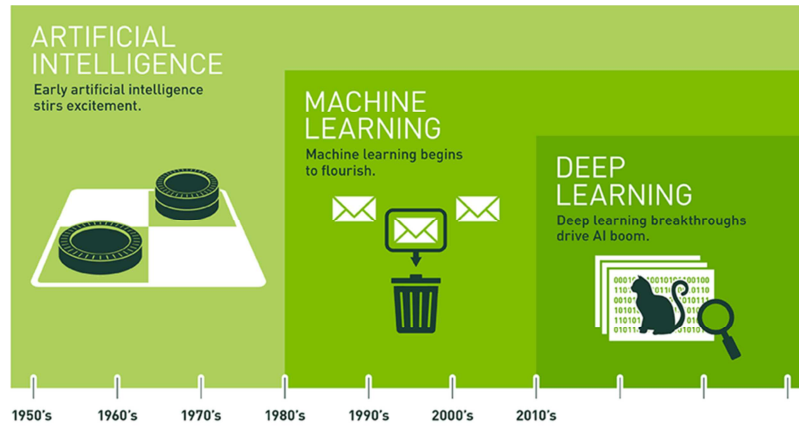


Figure 1. Deep Learning Category.

## 2. Deep Learning Frameworks

To understand the frameworks of deep learning, artificial neural network (ANN) is definitely starting point. [6] ANN is one of the main tools to achieve machine learning. ANN is a brain-inspired system created by human to imitate the way that animals learn, containing mainly three layers: input data for the first layer, hidden layer transforming the input data into the output data, while output data is presented in the third layer. Consisting of these three layers, neuron is the functional foundation. [7]

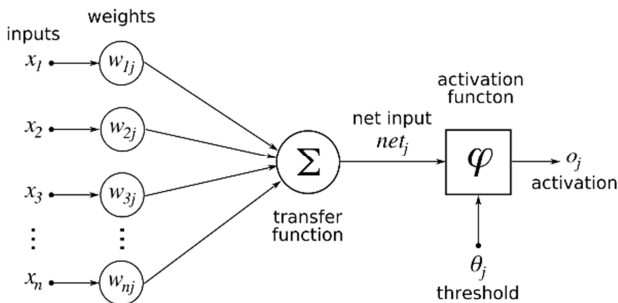


Figure 2. Deep learning Model.

The neuron model receives  $n$  input signals  $(x_1, x_2, x_3 \dots x_n)$ , which is multiplied by a corresponding weight  $(\omega_1, \omega_2, \omega_3 \dots \omega_n)$  and summed. The result is then processed by the activation equation, Sigmoid function in the typical case. The result can be compressed in the interval  $(0, 1)$ , then outputted based on its unique parameter, threshold  $\theta$ . The process can be expressed by the equation below:

$$y = f\left(\sum_{i=1}^n \omega_i x_i - \theta\right)$$

In the process of neural network training, the two parameters are adjusted to fit the continuous inputted data.

A single neuron model can be applied to simple problem operating only AND gates, OR gates and NOT gates. However,

when it comes to more complex problems, other operations may be needed, XOR gate for instance. At this time, one layer of neurons may not be able to solve it, and therefore, multiple layers of neurons are required in order to fit arbitrary complex continuous functions. This is so-called “deep learning”, the system calls for multiples layers of neurons. [8]

## 3. Types of Neural Network

Deep neural network with numerous layers of neurons comes with different ways of combinations of layers. Different types of neural networks are applied to different tasks and complexity.

Let's first consider the simplest case. Each layer is fully interconnected to its adjacent layers and has no peer or cross-layer connections. The data only flows from input to output directly. This artificial neural networks are called “Feed-forward Neural Networks” (FNN). In such case, an input  $x$  passes through equation  $f(x)$  and gets the output  $y$ . Weight and threshold of each neuron are adjusted to fit the situation. [9, 10]

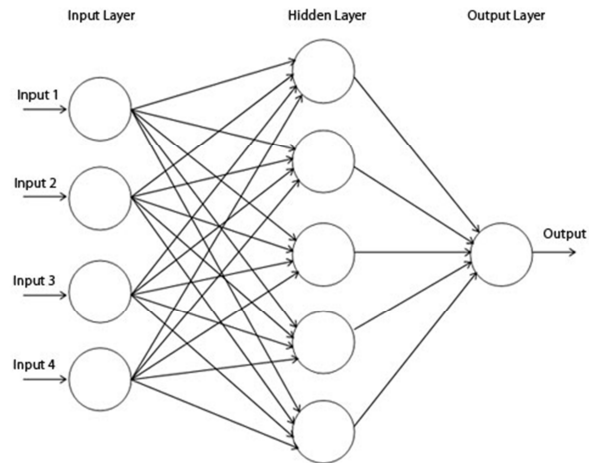


Figure 3. Feedforward Neural network.

When feedback is extended to FNN, it turns to a more prevailing type, "Recurrent Neural Network" (RNN). [11] Different from FNN, RNN memorizes the previous data inputted and makes prediction for future data. While sometimes the initial data maybe wrong and therefore makes wrong prediction, this will affect the parameters to change. To avoid such conditions, neural network can back propagate such data to the previous layer and adjust the weight for it to minimize the effect brought by it for the final result. This process is called gradient descent. With such system, RNN can be applied to more situations.

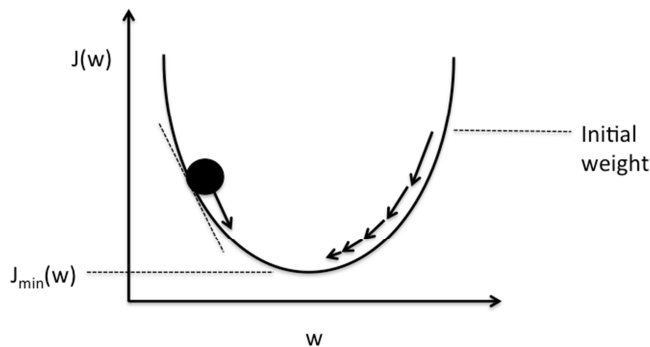


Figure 4. Gradient Descent.

## 4. Application of Deep Learning in Business

The presence of huge amounts of data in daily business activities is a perfect opportunity to utilize deep learning models. As showed above, there are different types of Neutral Networks which can be applied to different cases in business area. The following sections will explain from five perspectives of how deep learning can overcome some problems in business and other applications in business by some concrete examples.

### 4.1. Customer Service

It is known that customer service is a vital section in providing customers great experience of purchasing and increasing company's profit. Inversely, the cost of a terrible customer service is expensive. U. S. companies lose more than \$62 billion annually due to poor customer service. While improving the level of customer service is not an easy work. Businesses spend \$1.3 trillion on 265 billion customer service calls each year. Such big amounts of money are mainly for the salary and training fee for customer service staffs. But such job is actually mechanical, staffs spend great mass of time in answering repeated and simple questions. With all the understanding of deep learning, it makes people think that training deep learning model can replace customer services staffs. In this way, companies are able to lower the cost, and artificial model has greater efficiency than human which improve consumers' experience and in turn increases companies' profit. [12]

Nowadays, there are some companies which have already developed the deep learning model and applied it in the real life. For instance, DigitalGenius founded in 2013 focuses on applying deep learning model to customer service. DigitalGenius developed the "the first solution to enable end-to-end case resolution of your common repetitive journeys without human intervention." which is called "AutoPilot". During customer service, replying repeated questions is always the one that occupies the most time of staffs, while AutoPilot is the perfect tool for it. Companies which employ AutoPilot for their platform can train it by inputting samples. This enables AutoPilot to deal with the simple questions raised by consumers, and let staffs to spend their time on consumers who have individual requirement.

Based on the development of AutoPilot, DigitalGenius later launched a more advanced new product -- CoPilot. After receiving massive historical data, CoPilot can basically be qualified for the job of human staffs. In practice, after consumers raising a question, CoPilot will first analyze the problem and give out an answer. Then it will calculate the confidence level of the answer. If such confidence level exceeds a threshold, it can be directly outputted to customer. Otherwise, the answer will be sent as an advice for human staff who can choose either to approve the answer or to reedit it. During the process of giving answers and getting feedback, the model becomes more and more accurate itself. Again, CoPilot improves efficiency, lower the cost and average handling time (AHT).

Numerous Companies choose to employ products from DigitalGenius for their own, like TravelBird, StarOfService and KLM Royal Dutch Airlines. Take TravelBird for instance, after the Interference of DigitalGenius, the CSAT (Customer Satisfaction Score) soared to 90% after nine months, AHT (Average Handling Time) dropped by 30%, and the sales increased by 230% in a year. There is an optimistic prediction on the future applications of such deep learning models.

### 4.2. Sales

Selling job is closely connected to the profit of a company. In order to let more consumers to pay for the product, besides improving products quality and customer service, appropriate sales effort is also essential. Outstanding sales tools can aim at consumers who are more willing to purchase, and increase the total profit. While in real life, there are some obstacles for human staffs to recognize the best sales tool for consumers, introducing deep learning models can help out.

Data of potential can be easily obtained by companies, such as income level, education background and hobbies. [13] At the same time, the historical record of successful sales is available. Crucial information is actually hidden behind those massive data. For a normal sales person, it is hard to combine messy data together and extract the useful part. Therefore, the assist of deep learning model is necessary in order to filter the potential customers. In today's marketplace, one company is doing exactly the same job.

Salesforce developed intelligence -- Sales Cloud which assists salesman for better achievement. Its features consist of

three different parts: Einstein Lead Scoring, Einstein Opportunity & Account Insights and Einstein Activity Capture. Firstly, Einstein Lead Scoring plays an important role: determine the customers. It obtains and analyzes the past data of the companies to build a model of identifying the potential consumers. Based on the result provided by Einstein Lead Scoring, salesman can select the potential consumers with higher priority which increases the success rate. After setting up the customer list, company can continue using Einstein Opportunity & Account Insights which also analyzes based on past data. It finds the sales way that is best fitted to the companies and provides instant news, like customer sentiment or competitor involvement. Finally, Einstein Activity Capture connects to salesmen's emails and calendars and adds emails and events directly which saves their times.

Customers of Salesforce report 39% increase in sales productivity. Such accurate prediction of potential customers brings convenience to salesman and profit to corporations at the same time.

#### 4.3. Marketing

In modern business activities, the major problem is the selection of marketing methods. One product always faces different groups of target audience, while single marketing method does not work well for all the people. The presence of massive unstructured trading records will be an ideal place for deep learning model. A company named Persado has a great progress in this field. [14]

Persado focuses on building Language Cloud which is to design language that resonates with every customers and achieves better marketing effect. In October 2017, Persado released their product Persado One for the first time. Persado One learned from the past data to deconstruct both language elements and emotions for customers. Persado One assigns profiles for every customer to record individuals' situation, like age, income and education background. After gathering these data, Persado One will choose the most appropriate one for every customers. Then, the model will be modulated based on the real response from customers to certain language and emotions.

Persado One can provide more benefits compared to the traditional way of marketing. First, this brand-new way of marketing focuses more on customers' personal emotion which can lead to higher engagement of customers. For the same product, because of the physical restriction, traditional way can only emphasize one perspective or a brief over-all introduction of the product when facing multiple groups of potential customers. While different groups of people value different aspects of the product, it is difficult to attract all the groups. On the other hand, Persado one takes aim at every individual to customize marketing language which closely connected with every customers who will be more willing to purchase. On top of that, Persado One can insert photos with their language. Once the model combines words and pictures, an integral marketing content will be displayed. Second, the marketing language created by Persado One can be applied to different area, like advertising with emails, website and social media. This can replace people generated advertisements

excellently. Finally, deep learning model will both save the cost the companies invest into marketing and improve efficiency. Hundreds of corporations "use Persado to optimize marketing campaigns, resulting in a 49.5% average lift in conversions" According to Forrester Analyst Shar VanBoskirk, "By 2021, CMOs will spend nearly \$119 billion on search marketing, display advertising, online video, and email marketing." Increasing conversion rate definitely brings more business opportunity to companies. While with the appearance of Persado, the cost will be largely reduced.

#### 4.4. Daily Operation

There are many fields in daily operations, the following paragraphs will mainly focus on human resource management and internal communications. These jobs can be minor for small companies, while with the expansion of companies, these jobs become harder and harder. Therefore, deep learning model can lower the error rate and human cost. Three examples will be raised to illustrate the application of deep learning model in daily operations. [15]

The first task is the arrangement of regular meetings. Dealing with complicated meetings is a tedious work, while a product (called x. ai) based on the theory of deep learning solves the problem effectively. x. ai provides trained deep learning model as virtual assistant. It can understand the email content of clients and help them to do the schedule. The processes behind it is that when clients sending email to others to arrange work, they need to copy one to the virtual assistant and provide access rights at the same time. x. ai can then arrange all the meetings for clients with detailed places, time and people and reminds clients when the times come. In other words, x. ai as a personal virtual assistant does not replace other's jobs while it offers convenience for people who need to communicate a lot with others but without a personal assistant.

Recruitment event is the second task for deep learning model, including reading resumes and having interviews. Mya, a A. I. recruiting assistant, can help to pre-screen candidates. It is able to collect the basic information about and preliminarily assess candidates by communicating with them. Meanwhile, it also answers some questions from candidates like arranging interview. Based on Neuro Linguistic Program (NLP), it effectively lower work intensity of HR people. According to the official website of Mya, there is a 79% decrease in the time to hire when a recruiter works with Mya.

The final one is the documenting during meetings. For business, meetings is one of the main parts of the works. Human forces are always needed to record the content of meetings, while committing faults is inevitable for humans. However, Clarke, as a professional assistant trained by deep learning, can deal with this problem. Only by emailing or calling Clarke to invite it to attend the meeting, it can record the audio of meetings and compile a note automatically and silently. This helps the business workers to a great extent.

#### 4.5. Risks Management

Risk management is the vital part in business activity as it

goes through all processes when a project is carrying on. Because business activity is always accompanied by risks, knowing and mitigating risks is significant. In traditional commercial pattern, risk management includes identifying the condition and possibility of the occurrence of risk and seeking the optimal method to avoid it. The uncertainty of task makes it difficult for human to analyze even with experience and specific economic theory. However, deep learning model can still do a good job dealing with risks. [16, 17]

One typical example of risks is customer defection. Predicting and controlling the customers lost is vital as those customers is possible to flow into its competitors' hand. Studies by Bain & Company, along with Earl Sasser of the Harvard Business School, have measured that even a 5 percent increase in customer retention can lead to an increase in profits somewhere between 25 and 95 percent.

Deep learning can manage abundant non-structural data. Using this feature, Federico Castanedo published a paper called "Using Deep Learning to Predict Customer Churn in a Mobile Telecommunication Network" on Wise Athena using the theory of deep learning. Castanedo points out a custom churn prediction model. When massive past information of clients is inputted, this model can predict the actions of clients in every process of business activity, including future actions.

Deep learning model can analyze information involved multiple layers of information and statistics, which can hardly be done by human work. Mentioned by Castanedo in the article that "We use billions of call records from an enterprise business intelligence system and present our current work towards using deep learning for predicting churn in a prepaid mobile telecommunication network. To the best of our knowledge this is the first work reporting the use of deep learning for predicting customer churn. On average, our model achieves 77.9% AUC1 on validation data, significantly better than our prior best performance of 73.2% obtained with random forests and an extensive custom feature engineering applied to the same datasets."

Although deep learning model like a black box operation, which cannot give out reasons for the result, it still has a significant meaning in real applications. Moreover, inspired by this problem of customer churn, we can imagine that many business risks can be controlled by introducing deep learning. For example, if the partnership between enterprises breaks down and has a huge impact on both sides, can a deep learning model control it? [18]

## 5. Conclusions

Deep learning can be applied to various areas of business activities, in customer service can help practitioners more reasonable and efficient communication with customers, in marketing and sales can improve sales, increase profits, in daily operations, can improve efficiency, save human resources, facilitate each practitioner, in the wind, in terms of risk management, there are also suitable models for user behavior prediction.

Deep learning model has more applications in business activities besides from five perspectives mentioned above. More importantly, this article discusses the basic theory of deep learning, which refers to the best application of deep learning in what kind of data sets and actual scenarios. It is pointed out that deep learning is very suitable for business activities. At the same time, this article discusses the successful application of deep learning in business activities, which will give every practitioner inspiration. In their work, people can use the tool of deep learning very well and get good results.

It is clear that deep learning will have a considerable effect in this "Big Data Time". [19] It not only can replace human in some repeated or time-wasting work, but also can analyze the trend that human work cannot achieve. Deep learning has only been developed through the recent years, but the achievements are incredible. On the other hand, it is inevitable that deep learning creates unemployment. It is hard to predict that what will deep learning bring us in the future since in a fast-changing time, but it will definitely have great impacts on us – with both positive and negative effects. People have to find a balance point between the usage of deep learning.

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## References

- [1] Rina Dechter, National Conference on Artificial Intelligence. Philadelphia, 178-185, 1983
- [2] Lecun Y, Bengio Y, Hinton G, Nature, 2015, 436-444, 2015.
- [3] Deng, Li, and D. Yu, Foundations & Trends in Signal Processing, 197-387, 2014
- [4] Schmidhuber J, Neural Networks, 85-117, 2015
- [5] Howard, Jeremy, ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, 1135-1135, 2013
- [6] Yao, Xin, Proceedings of the IEEE, 1423-1447, 1999
- [7] Hassoun, Mohamad H, Proceedings of the IEEE, 84 (6) :906, 2002
- [8] Widrow, Bernard, and M. A. Lehr, Proceedings of the IEEE, 1415-1442, 2002
- [9] Ahn, B. S., S. S. Cho, and C. Y. Kim, Expert Systems with Applications, 65-74, 2000
- [10] Sanger, Terence D. Neural Networks, 459-473, 1989
- [11] Williams, Ronald J., and D. Zipser, MIT Press, 270-280, 1989.
- [12] Xu, Anbang, et al. CHI Conference on Human Factors in Computing Systems ACM, 3506-3510, 2017
- [13] Agrawal, et al. Computer Engineering & Applications, 619-624, 2000

- [14] Glorot, Xavier, A. Bordes, and Y. Bengio, International Conference on International Conference on Machine Learning Omnipress, 513-520, 2011
- [15] Ghaphery, Jimmy, and S. Stearns. "Making the Most of Your Data: Embedding Business Intelligence into Daily Operations." 2013.
- [16] Spanoudes, Philip, and T. Nguyen, "Deep Learning in Customer Churn Prediction: Unsupervised Feature Learning on Abstract Company Independent Feature Vectors.", 2017
- [17] Kvamme, Havard, et al, "Predicting Mortgage Default using Convolutional Neural Networks." Expert Systems with Applications 102, 2018
- [18] Singh, Kulwant, and W. Mitchell, Strategic Management Journal, 99-115, 1996
- [19] Waller, Matthew A., and S. E. Fawcett, Journal of Business Logistics, 77-84, 2013