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Deep Learning

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***Abstract*—** *Deep learning refers to a family of approaches that have taken machine learning to a new level, helping computers make sense out of vast amounts of data in the form of text, images, and sound. Deep learning algorithms are used to train deep networks with large amounts of data. In this paper, we provide a brief introduction to deep learning.*

***Keywords*—** *Deep learning, deep machine learning, hierarchical learning*.

I. INTRODUCTION

Deep learning (DL) is a new area emerging from machine learning and multilayer neural network. It has come to the forefront as a way of overcoming the limitations of neural networks when they are employed to real-world challenges.

The term "deep learning" was coined in 2006 by Geoffrey Hinton and Ruslan Salakhutdinov [1]. Currently, neural network learning algorithm is mainly shallow neural network, consisting of an input layer, a hidden layer, and an output layer. A typical deep neural network consists of an input layer, three hidden layers and an output layer [2]. A shallow learning model consists of only one layer responsible for transforming the input signals. Examples of shallow architectures are conventional hidden Markov models, while examples of deep architectures are convolutional networks [3, 4].

Deep learning extracts complex features from high-dimensional data and applies them to develop a model that relates inputs to outputs. The most common form of deep learning architectures is multi-layer neural networks. Deep learning has many advantages over shallow learning. DL algorithms transform their inputs through more layers than shallow learning algorithms.

Note that the deep learning discussed in this paper is a sub-field within machine learning. It is not the overloaded term in educational psychology, where deep learning describes reproduction and categorizing information learned in the classroom [5, 6].

II. APPLICATIONS

Deep learning may be regarded as a feature learning technique. Different applications employ different deep learning models. Deep learning has matured from being a special purpose machine learning technique to a general purpose machine learning tool. It has become a big wave of technology trend for big data and artificial intelligence. It has enjoyed success in various applications such as automatic speech recognition, image recognition, computer vision, object detection, bioinformatics, and other areas such as drug discovery and information retrieval [7].

Speech Recognition: Deep learning has revolutionized speech recognition. Large-scale automatic speech recognition is the first and most persuasive case of DL recently. All major commercial speech recognition systems, such as Google Now, Skype Translator, and Microsoft Cortana, are based on DL algorithms. DL has improved voice search on smart phones.

Image Recognition: Deep learning algorithms have shown excellent learning in image recognition problem, such as handwritten classification. They develop advanced pattern recognition systems modeled after human perception. An example is a car computer trained with deep learning which may enable the car to interpret 360^o camera views.

Medical Informatics: Deep learning has been applied in the health domain such as in predicting sleep quality and predicting health complications. DL has been used to detect toxic effects of environmental chemicals in nutrients and drugs.

Recently, companies such as IBM, Microsoft, Google, Apple, and Baidu have invested and developed deep learning. They have taken advantage of their massive data and large computational power to deploy deep learning on a large scale. However, the models developed on the data remain proprietary.

III. CHALLENGES

There are three challenges to be overcome before deep learning can be widely adopted in other application areas [8, 9]. First, there is the challenge of usability. The implementation of different models must be done by nonexperts with little difficulty. The training algorithms must not be difficult to debug. Second, there is the challenge of scalability. The deep learning system must be capable of handling large demand of computing resources. Third, data collection required for deep learning presents privacy issues. Several data owners, such as medical institutions, are prevented from sharing their data due to privacy and confidentiality concerns.

Despite that deep learning is emerging as a very powerful technique, it is attracting some criticism. One major criticism is the lack of theory surrounding the technique. DL techniques are often considered as decision-making black boxes. In a field that aspires to model something as profound as human brain, it is inevitable that a single technique would not solve all the challenges.

IV. CONCLUSION

Deep learning neural networks is a sub-field of machine learning and it can be used to model complex relationships among data. DL has given a new dimension to the machine learning research. DL models represent a newly emerging generation of neural networks and are solving problems that were hard to solve in the artificial intelligence. DL methods achieve high accuracy for tasks where a large amount of data is available. Advances in technology have enabled the

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renewed interest in DL. Although DL has achieved some success and found applications in various fields, it is still in its infancy.

REFERENCES

[1] G. E. Hinton and R. R. Salakhutdinov, "Reducing the dimensionality of data with neural networks*," Science*, vol. 313, pp. 504-507, 2006.
[2] P. Kuang, W. N. Cao, and Q. Wu, "Preview on structures and algorithms of deep learning," *Proceedings of the 11th International Computer Conference on Wavelet Active Media Technology and Information Processing (ICCWAMTIP)*, pp. 176-179, 2014.
[3] L. Arnold et al., "An introduction to deep learning," *Proceedings of European Symposium on Artificial Neural Networks, Computational Intelligence and Machine Learning*, pp. 477-488, April 2011.
[4] D. Yu and L. Deng, "Deep learning and its applications to signal and information processing," *IEEE Signal Processing Magazine*, pp. 145-154, Jan. 2011.
[5] T. W. Smith and S. A. Colby, "Teaching for deep learning," *The Clearing House: a Journal of Educational Strategies*, vol. 80, no. 5, pp. 205-210, 2007.
[6] M. Turner and R. Baskerville, "The experience of deep learning by accounting students," *Accounting Education*, vol. 22, no. 6, pp. 582-604, 2013.
[7] "Deep learning" Wikipedia, https://en.wikipedia.org/wiki/Deep_learning
[8] W. Wang et al., "Deep learning at scale and at ease," *ACM Transactions on Computer Communication Applications*, vol. 12, no. 4s, pp. 69:1-69:25, Nov. 2016.
[9] R. Shokri and V. Shmatikov, "Privacy-preserving deep learning," *Proceedings of the 22nd ACM SIGSAC Conference on Computer and Communications Security*, pp. 1310-1321, 2015.

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