Further Utilization and Introduction of AI (Artificial Intelligence) in River Management Practice.

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1.   Introduction

The scope of application of Artificial Intelligence (AI) has been expanding. It is used in various fields including medical care, automatic driving, and agriculture, as well as in the fields of image recognition, speech recognition, etc., which have conventionally been developed in machine learning.

In the field of river management, further utilization of AI is also expected since observation and measurement data that contribute to river management are being accumulated enormously, including the data of radar rain gauges, crisis management type water gauges, aerial laser, and MMS (Mobile Mapping System). Accordingly, we have been reviewing the trend of studies on AI, which has been rapidly expanding in recent years, and conducting a research for further utilization of AI, targeting the field of hydrology, where AI utilization has been more often discussed in the practice of river management.

2.   Progress of AI technology

Since the study by G. Hinton, 2006, AI, particularly neural network technology, has rapidly developed. [1)-3)]
Figure 1 provides the number of papers contributed according to the main models of AI.[4)] **The Figure** shows that the trend of increase in the number of papers contributed is particularly recognized in the models of Convolution Neural Network (CNN)[5),] which is mainly used in the field of image recognition, Long / Short Term Memory (LSTM)[6),] suitable for handling time series data, AutoEncoder [5)], one of the prior learning approaches for multilayer network, and Generative Adversarial Network (GAN)[7)], which enables formation of high-definition images.

3.   AI utilization in the field of hydrology

In the field of hydrology in Japan, shallow Artificial Neural Network (ANN) has mainly been studied. [8)] As issues that arise in application of shallow ANN, no assurance of accuracy of calculation for unprecedented rainfall, increase in calculation error according to increase in the number of input data, etc. have been known, while efforts have been made to improve the accuracy of calculation by building multi-layer ANN.[9)]

4.   Conclusion

In the future, it is necessary to evaluate applicability in the field of hydrology for the aforementioned CNN, LSTM, AutoEncoder, and GAN.
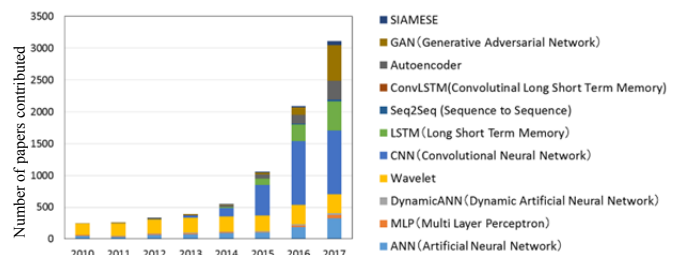

Fig. 1: Number of papers contributed according to each model

☞See the following for details.
1) G. E. Hinton, S. Osindero, Y. Teh: A Fast Learning Algorithm for Deep Belief Nets, Neural Computation, Vol.18, pp.1527-1554, 2006.
2) Takayuki Okaya: "Deep Learning," Kodansha Scientific, 2015.
3) Osamu Okada, Kazuhiro Kakizawa, Masaaki Nakayasu, Tadashi Tadokoro: "Flood Forecast and Detection of Abnormal Water Level Data using AI," Collection of Presentations in the River Information Symposium, pp. 5-1-5-16, 2017
4) Cornell University Library: arXiv.org https://arxiv.org/
5) G. E. Hinton, R. R. Salakhutdinov: Reducing the dimentionality of data with neural networks, Science, Vol.313, No.57866, pp.504-507, 2006.
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7) I. J. Goodfellow, Y. Bengio, A. Courville, Deep Learning, MIP Press, 2016.
8) e.g., Isamu Isobe, Teruo Ohkohdo, Hidehiko Hanyuda, Seiichi Oda, Yusuke Gotoh: "The Development of a Forecasting System of the Water Levels of Rivers by Neural Networks," Journal of the Japan Society of Hydrology and Water Resources, Vol.7, No.2, pp. 90-97, 1994.
9) Masayuki Hitokoto: "Flood Forecast using AI --- Accuracy improvement by application of deep learning," Journal of the Japan Society of Civil Engineers, Vol.103, No.2, pp. 30-31, 2018