Automatic Construction of Generative Model by Deep Learning for Earth and Space Sciences

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Deep learning outperforms methods of machine learning by means of overwhelming performance in the three fields of image / video processing, audio processing (recognition), natural language processing, and its computing platform free of charge is provided from various companies. A time when a certain kind of "serenity" era has changed completely, as influential statistical machine learning techniques competed. The reasoning technique for effectively utilizing data is an induction method, and the basis of the induction method is statistics and related mathematics. Statistical researchers suggest that deep learning is just one nonlinear function and can never avoid various difficulties induced by problems related to inherent parameter estimation (learning). So why did deep learning achieve the great results so far and have you attract many young people? The authors think that the strength of deep learning lies in having the "metrological" nature of artificial intelligence technology brought about by the appearance of big data. With this "metrological" nature", the deep learning becomes a common means in at least three information processing fields of image / motion picture, speech, natural language, and it is a commodity not to deeply require mathematical consideration for application. Furthermore, in recent years, the use form of deep learning has been shifting from the search for an identification (discriminative) model to the construction of a generative model. The merit of acquiring a generative model is extensive, such as missing / abnormal value processing of data, risk analysis, inverse analysis using Bayes' theorem. Its utility is extremely high for the Earth and space science. In the future, I anticipate that the target of deep learning research will head toward automatic construction of generative models.

Deep layer neural networks have been often used as discriminative models, but researches that are used for generation models are more active than in the past 2 to 3 years. The reason for this is in overcoming the "crying place of Benkei" (namely, heel of Achilles) in deep learning such as readability of results and correspondence to small data. The readability of the result means whether "human" is easy to understand learning results from data such as parameter estimation and structure learning of the network (model selection). Specifically, it is often said that deep learning is a black box, but a simple statistical model such as a linear regression model explicitly expresses the relation between variables. Another challenge which is related to the handling of small data is that deep learning always requires a huge amount of data. In that case, it is effective and simple solution to generate large quantities of data with a certain model for simulations. In this presentation, we will discuss several promising fields of future application of deep learning taking up several technologies.

Keywords: Deep Learning, Generative Model, Emulation, Statistical Downscaling, Latent Variable Modeling, Purpose Specialized Computer

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