Application of artificial neural network to cosmological 21cm signal

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Our knowledge of the Universe has increased due to the development of observational instruments. In particular, the observations of cosmic microwave background and large scale structure of the Universe are two pillars of modern standard cosmology model. Based on standard cosmology model, we try to understand epoch and environment when first stars and galaxies formed. In my study, I especially focus on special epoch called "Epoch of Reionization (EoR)". The dominant component of the Universe is hydrogen atom. Before the EoR, hydrogen atom present in the Universe was neutral. However, high energy photons emitted by first stars and galaxies ionized neutral hydrogen and phase of the Universe was dramatically changed.

Since no observation has reached the EoR, we have not established standard model of the EoR yet. Thus, we can only consider the EoR with numerical simulation and theoretical model at present stage. However, some radio observations aimed to the EoR is ongoing and we expect that we can observe the EoR in 2020s. The target of the observation is radio wavelength electromagnetic wave which is emitted by neutral hydrogen atom, called '21cm signal'. The 21cm signal is caused by hyperfine structure of neutral hydrogen atom.

In my study, I use the artificial neutral network (ANN), which is one of the machine learning techniques, to connect the numerical simulated 21cm signal data to expected observational data. The advantage of machine learning methods is that we can treat huge number of data and extract information, which is needed to determine the EoR model, from that data. I discuss how accurately I can determine the EoR model with ANN. The new point of my study is not only that I introduced the ANN into the study of the EoR in order to treat huge numerical simulation data for the first time and also that I could show ANN is very powerful tool to determine the EoR model parameters.