Gaussian Process Regression: An Application to Radio Cosmology

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Abstract

Neutral hydrogen (HI) intensity mapping is a novel technique able to probe the 3D large-scale structure of the Universe over very large volumes very quickly. By treating HI as a diffuse background, we are able to use the integrated 21cm emission of HI in galaxies as a biased tracer for the underlying dark matter distribution. It is possible to then calculate statistics such as the HI power spectrum. However, in order to achieve high precision and accuracy using HI intensity mapping, instrumental and systematic effects must be properly accounted for. In particular, astrophysical foregrounds dominate over the signal by several orders of magnitude, and need be adequately removed.
I look at the performance of Gaussian Process Regression (GPR) as a foreground removal technique. This non-parametric technique is able to statistically separate the spectrally smooth foregrounds from the HI cosmological signal. While this technique has been applied to interferometric 21cm data from the Epoch of Reionization, I apply it for the first time to single-dish, large scale structure studies. Specifically, I apply GPR as a foreground removal technique to SKA-like simulations, which include instrumental and foreground effects. I conclude by comparing the performance of GPR in recovering the HI cosmological signal to other foreground removal methods, such as Principal Component Analysis.

Slides: in PDF
Video: https://youtu.be/iE_fedOjLxA

Keywords: large, scale structure, foregrounds, intensity mapping, neutral hydrogen, radio cosmology

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