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Conditional generative adversarial networks for the improvement of signals decomposition methods

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Abstract

In general, analysis of nonlinear and non-stationary processes is a challenging task. Real-life signals are mostly nonstationary and nonlinear, then there is a need to study and interpret these measured signals to help improve our lives in many fields including Medicine, Geophysics, Engineering, Information Technology, Economics, etc. To study this kind of signals there is a need to perform a time-frequency analysis. One way of performing time-frequency analysis is by decomposing the signal into simpler oscillatory components called Intrinsic Mode Functions (IMFs) which are analyzed separately. This approach is known as the decomposition method. Another approach of performing signal analysis is using Fourier and Wavelet based techniques. The decomposition approach has been shown to handle the nonstationarity of a real life signal better than the Fourier and wavelet based techniques. The first ever decomposition method is the Empirical Mode Decomposition (EMD) developed by Haung et al. in 1998 [1]. Any of the signal decomposition method deal with compactly supported signals, which requires assumptions on how the signal extends outside the boundaries, the so-called Boundary Conditions (Bcs) and this results in "end effect" observed after applying any decomposition method on a signal.

In this work we focus on the development of a method to extend 2-d signals to reduce boundary effects when decomposition methods are applied to 2-d signals. Most of the traditional methods including zero padding, reflective extension and others, do not perform well when 2-d real life signals are decomposed. In fact, a high level of boundary effects is generated. Therefore, there is the need to find other approaches to extend 2-d signals. We briefly discuss methods for the decomposition of signals and a novel extension method is proposed, which is a combination of the traditional methods and conditional generative adversarial networks (cGANs) [2]. Finally, real life examples of 2-d signal extensions are presented and analyzed.

The idea of using cGANs, a machine learning technique showed to be promising in extending the 2-d signals naturally, then such idea can be applied for ionospheric modeling (e.g. TEC nowcasting and forecasting). *Extended Abstract*.

References

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