Abstract

At present, the vast majority of deep learning architectures are based on real-valued operations and representations. However, recent works and fundamental theoretical analyses suggest that complex numbers can have richer expressiveness: many deterministic wave signals, such as seismic, electrical, or vibrational, contain information in their phase, which risks being lost when studied using a real-valued model. However, despite their attractive properties and potential, only recently complex-valued algorithms have started to be introduced in the deep neural networks frameworks.
In this work, we move forward in this direction developing and implementing a coherent and working structure to train complex-valued models, remaining rigorous from a mathematical perspective but, at the same time, seeking for stability and accuracy of the training process.
As a first application of this solution, we show the results obtained applying complex-valued deep neural networks for condition monitoring in industrial applications. Different Deep Network architectures have been trained on vibrational signals extracted from sensors attached to gearmotors to detect failures. Finally, we compare the performances obtained with real and complex-valued neural networks.