Echo state network and variational autoencoder for efficient one-class learning on dynamical systems

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Abstract

Usually, time series acquired from some measurement in a dynamical system are the main source of information about its internal structure and complex behavior. In this situation, trying to predict a future state or to classify internal features in the system becomes a challenging task that requires adequate conceptual and computational tools as well as appropriate datasets. A specially difficult case can be found in the problems framed under one-class learning. In an attempt to sidestep this issue, we present a machine learning methodology based in Reservoir Computing and Variational Inference. In our setting, the dynamical system generating the time series is modeled by an Echo State Network (ESN), and the parameters of the ESN are defined by an expressive probability distribution which is represented as a Variational Autoencoder. As a proof of its applicability, we show some results obtained in the context of condition-based maintenance in rotating machinery, where vibration signals can be measured from the system, our goal is fault detection in helical gearboxes under realistic operating conditions. The results show that our model is able, after trained only with healthy conditions, to discriminate successfully between healthy and faulty conditions and overcome other classical methodologies.

Palabras clave

Palabras clave de autor: Dynamical system modeling; deep learning; reservoir computing; variational inference

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