SUPERVISOR MODULE

DATA-DRIVEN MODELLING OF NONLINEAR CIRCUIT BEHAVIOR

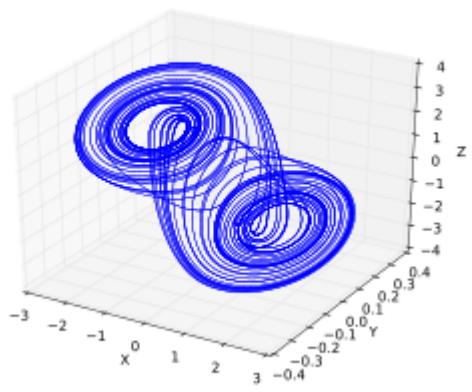
Details Studenten

This thesis starts from a technique called Sparse Identification of Nonlinear Dynamics (SINDy). SINDy aims to extract the governing equations of a nonlinear dynamical system from measured time-series data. It uses a dictionary of candidate functions, such as polynomials and trigonometric terms, and expresses the dynamics as a sparse combination of these candidate functions, ensuring a balance between accuracy and model simplicity. This approach enables the discovery of human-interpretable, data-driven models and it does so by solving a linear set of equations under sparsity constraints.

As we aim to identify nonlinear systems, the dictionary used in SINDy is constructed using monomials of the basis *x_1*,*x_2*,*x_3*,... and functions of those monomials. Example elements from the dictionary include *x_1 x_2^2* and *sin(x_1 x_2^2)*. A key challenge that SINDy faces is the curse of dimensionality. This curse arises because the number of monomials, for a fixed number of basis elements n, grows exponentially with the monomial degree d as *O(d^n).* Consequently, the dictionary used in SINDy can become very large and the computation expensive.

A second key challenge that SINDy encounters is the choice of the function dictionary and the coordinate basis. Without appropriate choices, SINDy fails to model the data, as the sparsity of the representation is lost under basis transformations. In many applications, determining the proper basis beforehand is challenging, if not impossible.

The goal of this thesis is to break the curse of dimensionality by replacing the sparsity constraint by a low-rank constraint. At the same time, the low-rank approach will eliminate the basis selection problem. We will showcase the approach on the modelling of nonlinear circuits, such as Chua's circuit.



Simulation of Chua's circuit, showing a chaotic double scroll attractor. (Figure taken from Wikipedia.)

Bijlagen

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VOEG TOE

Promotoren	Co-promotoren	Mentors	Assessoren
Lieven De Lathauwer			

Naam organisatie / URL

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Opmerkingen

Contact moments are both possible on Campus Leuven (ESAT) and Campus Kortrijk (Kulak).

Information Systems and Signal Processing

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Laatst gewijzigd door

Lieven De Lathauwer

Aantal studenten

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