Parameterizing Coefficients of a POD-Based Dynamical System

A method of parameterizing the coefficients of a dynamical system based of a proper orthogonal decomposition (POD) representing the flow dynamics of a viscous fluid has been introduced. (A brief description of POD is presented in the immediately preceding article.) The present parameterization method is intended to enable construction of the dynamical system to accurately represent the temporal evolution of the flow dynamics over a range of Reynolds numbers.

The need for this or a similar method arises as follows: A procedure that includes direct numerical simulation followed by POD, followed by Galerkin projection to a dynamical system has been proven to enable representation of flow dynamics by a low-dimensional model at the Reynolds number of the simulation. However, a more difficult task is to obtain models that are valid over a range of Reynolds numbers. Extrapolation of low-dimensional models by use of straightforward Reynolds-number-based parameter continuation has proven to be inadequate for successful prediction of flows.

A key part of the problem of constructing a dynamical system to accurately represent the temporal evolution of the flow dynamics over a range of Reynolds numbers is the problem of understanding and providing for the variation of the coefficients of the dynamical system with the Reynolds number. Prior methods do not enable capture of temporal dynamics over ranges of Reynolds numbers in low-dimensional models, and are not even satisfactory when large numbers of modes are used.

Confidence-Based Feature Acquisition

Confidence-based Feature Acquisition (CFA) is a novel, supervised learning method for acquiring missing feature values when there is missing data at both training (learning) and test (deployment) time. To train a machine learning classifier, data is encoded with a series of input features describing each item. In some applications, the training data may have missing values for some of the features, which can be acquired at a given cost. A relevant JPL example is that of the Mars rover exploration in which the features are obtained from a variety of different instruments, with different power consumption and integration time costs. The challenge is to decide which features will lead to increased classification performance and are therefore worth acquiring (paying the cost).

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Algorithm for Lossless Compression of Calibrated Hyperspectral Imagery
NASA’s Jet Propulsion Laboratory, Pasadena, California

A two-stage predictive method was developed for lossless compression of calibrated hyperspectral imagery. The first prediction stage uses a conventional linear predictor intended to exploit spatial and/or spectral dependencies in the data. The compressor tabulates counts of the past values of the difference between this initial prediction and the actual sample value. To form the ultimate predicted value, in the second stage, these counts are combined with an adaptively updated weight function intended to capture information about data regularities introduced by the calibration process. Finally, prediction residuals are losslessly encoded using adaptive arithmetic coding.

Algorithms of this type are commonly tested on a readily available collection of images from the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) hyperspectral imager. On the standard calibrated AVIRIS hyperspectral images that are most widely used for compression benchmarking, the new compressor provides more than 0.5 bits/sample improvement over the previous best compression results.

The algorithm has been implemented in Mathematica. The compression algorithm was demonstrated as beneficial on 12-bit calibrated AVIRIS images.

This work was done by Aaron B. Kirby and Matthew A. Klimesh of Caltech for NASA’s Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-46547

Universal Decoder for PPM of any Order
Complexity can be reduced and flexibility increased, at small cost in performance.
NASA’s Jet Propulsion Laboratory, Pasadena, California

A recently developed algorithm for demodulation and decoding of a pulse-position-modulation (PPM) signal is suitable as a basis for designing a single hardware decoding apparatus to be capable of handling any PPM order. Hence, this algorithm offers advantages of greater flexibility and lower cost, in comparison with prior such algorithms, which necessitate the use of a distinct hardware implementation for each PPM order. In addition, in comparison with the prior algorithms, the present algorithm entails less complexity in decoding at large orders.

An unavoidably lengthy presentation of background information, including definitions of terms, is prerequisite to a meaningful summary of this development. As an aid to understanding, the figure illustrates the relevant processes of coding, modulation, propagation, demodulation, and decoding. An M-ary PPM signal has M time slots per symbol period. A pulse (signifying 1) is transmitted during one of the time slots; no pulse (signifying 0) is transmitted during the other time slots.

The information intended to be con-